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The 1,200 HP. electric locomotives, which the Thomson-Houston Co. is building to operate trains on the Baltimore Belt Line tunnel, will have four pairs of driving wheels and will weigh 80 tons. The "Electrical World" states that there will be a separate 300-HP. motor for each axle, the armature being keyed directly to the axle. The current will be taken from a third rail of iron or from a large copper tube, by some form of sliding contact. The conductor will be thoroughly insulated, and will be supplied with feeders at frequent intervals. The potential used will be 500 volts. Two of the locomotives are expected to be in steady use, the third being held in reserve. The electricity will be generated at a central power station, where four compound Corliss engines of about 750 HP. each will drive direct the coupled dynamos. The train movement in the tunnel will be about 400 trains daily. Besides hauling this, it is intended to employ the electric locomotives as pushers for heavy freight trains on a 1¼% grade, just beyond the tunnel. The results of the experiment will be watched with great interest. The load on the central station of an ordinary electric railway is variable enough; but the variations in this case will be such as in a common installation is sufficient to cause a wreck. The governing arrangements will need to be remarkably perfect to cope with the sudden throwing on or off of a load of 2,400 HP., or the total load on the central station.

The respective duties of the Superintendent of Tracks and of the Chief Engineer on the Chicago & West Michigan Ry. are defined in an order issued by the General Manager on July 1. The former officer has only the maintenance of the roadway under his charge, and the supervision of bridges, culverts and buildings is transferred to the Chief Engineer. The latter officer also has charge of all new construction, of the inspection of bridges and buildings and materials purchased for uses in his department.

Proposals for the construction of the naval drydock at Puget Sound, Washington, the plans for which were published in our issue of May 19, were opened July 5 in the Bureau of Yards and Docks, Navy Department, Washington, D. C. The bids were as follows, and where two or more bids have been made by one firm they have been based on the use of different kinds of stone: Matthew Brannagan, Seattle, Wash., $418,000; Daniel McPhee, Port Townsend, Wash., $446,207; J. P. M. Phillips, San Francisco, Cal., $480,500 and $500,500, both bids conditional; San Francisco Bridge Co., San Francisco, Cal., $516,000 and $525,000; Foster & Huson, Tacoma, Wash., $526,605; Cantard & Shahan, New Whatcom, Wash., $530,211, $546,273 and $529,749; Nelson Bennett, Tacoma, Wash., $568,348 and $588,548; Henry & Balch, St. Paul, Minn., $590,000; Hill & Co., Seattle, Wash., $619,000; J. E. Simpson & Co., New York, N. Y., $639,000; Rigby & Evans, Seattle, Wash., $669,000; California Bridge Co., Alameda, Co., Cal., $679,448. The drydock will be 605 ft. long, 130 ft. 1½ ins. wide at top, and 39 ft. 3 ins. deep, with a draft of 30 ft. over the sill at mean high water. The plans were prepared by Mr. M. T. Endicott, of the Bureau of Yards and Docks, and provide for a timber drydock of a form recently patented by him, with a masonry and concrete entrance and steel caisson or floating gate.

The Toronto Esplanade movement, to lift the present surface tracks now running along the water front of the city upon an elevated structure and at the same time construct a new union station, seems to be approaching a point where the actual work of improvement will soon begin. It is now announced that the various parties, viz., the city of Toronto, Ont., and the Canadian Pacific and Grand Trunk railways, have arrived at a settlement and that the formal agreement will soon be signed. A complete description of the present condition of the water front and the proposed plans of the improvements were given in our issues of Jan. 4 and 11, 1890.

Extensive drainage systems for some of the recently flooded areas in Chicago are projected at a reported cost of some $2,000,000. Several large pumps are included in the plan, which seems to involve the construction of large storm sewers.

The details of the River and Harbor bill have finally been agreed upon by the conference committee, and its report has been accepted by both houses of Congress. The appropriation for the Dalles boat railway, which was one of the items on which the House and Senate disagreed, was finally omitted. The completed bill appropriates $21,153,618 and authorizes the undertaking of further works whose total cost is set at $31,555,491.

The contractors on the Niagara Falls tunnel, Messrs. Rogers & Clement, will finish their work about July 23. The excavation is finished and it is only a portion of the masonry lining which remains to be done. The contract called for the completion of the work July 1, under a penalty of $100 per day; but as the contractors have hauled the excavated rock a greater distance than the contract required in order to fill in submerged lands belonging to the company, the time was extended to Aug. 1. Work on the excavation of the wheel pit is making rather slow progress, partly on account of the great amount of water encountered. Press reports state that the flow is 25,000 to 30,000 gallons per minute, which is handled by five pumps. The reporter probably got minutes and hours confused, since a flow as large as he states would be 36,000,000 to 43,000,000 gallons per day. It will probably be several months before the wheel pit is sunk to the tunnel level.

A garbage cremator with a daily capacity of 50 cu. yds. of refuse is to be built at Salt Lake City by the Engle Sanitary & Cremation Co., of Iowa. The contract price is $12,000.

A garbage cremator built by Mr. Heavey has recently been put into experimental operation at Chicago, Ill., and the city officials are said to be very strongly in favor of this method of garbage disposal. The present furnace has a capacity of 150 tons per 24 hours, and is divided into four chambers.

The most serious railway accident of the week was a head collision July 9, on the Pennsylvania R. R., at Big Chickies bridge, near Landisville, Pa. A special westbound train of Pullman cars had been run on the side track at Landisville to allow the first section of the Philadelphia express to pass; the special was then given the right of way, and the second section of the Philadelphia express was ordered to lay over at Mount Joy. The engineman, however, tried to run to Landisville, disregarding his orders. The special had just pulled out, when the second section of the Philadelphia express came up and the two engines collided on the bridge. The speed of both trains had been reduced. Both engines were telescoped, but did not fall from the bridge, which is over 30 ft. high. The baggage car of the eastbound train was also wrecked. Three men were slightly injured.

A retaining wall at the yards of the Newport News & Mississippi Valley R. R. near the union station, Memphis, Tenn., gave way July 8, and a large section fell over on the tracks, wrecking two Pullman cars and killing two men. The wall was about 22 ft. high, and, according to report, was built of cut limestone blocks about 2×3×8 ft., weighing nearly two tons each. The section which fell was about 300 ft. long. The following account is taken from a statement by Mr. Niles Merriwether, City Engineer, published in the Memphis "Appeal-Avalanche."

The wall was completed a couple of years ago at a cost of about $45,000, and I considered it as fine a piece of masonry as I had ever seen. It was built of cut limestone, from the Bedford quarries, the same as the stone of which the piers of the bridge across the river are built. The stones were laid in Portland cement. The plans for the work were drawn up by J. L. Frazier, Chief Engineer of the Chesapeake & Ohio Ry. Mr. A. T. Sabin, of Louisville, was the assistant, and L. A. Washington was the resident engineer in charge of the work—all of them competent men. The wall ranges in height from 20 to 23 ft. It is built on a cement foundation 5 ft. 10 in. broad, has a slope of 1 in 12 and rises to a coping 2 ft. 10 ins. wide. The bluff in the rear of the wall is excavated slantingly, the excavation being about 10 ft. across at the top and sloping down to the foot of the wall so as to make a triangular section, which was filled with earth taken from the adjoining streets. The tendency of the filling would naturally be to press downward. If there were any reasonable danger of the wall pressing out, it would be at the bottom. But the engineers provided safeguards against that by building several solid masonry buttresses from the wall back into the earth about eight feet. They are not visible now, because the break in the wall does not extend down deep enough. In view of the solidity of the wall and the precautions taken by the engineers, I can account for the wreck only on one theory: that the filling behind the wall became filled with water until it was a liquid mass, and that the hydrostatic pressure thus occasioned pushed the wall outward simultaneously from top to bottom. The stones were smooth. They might have been "grouted" so that the cement would have held them better. But there is no criticism of the wall to be made. The wreck was an accident that the best science is liable to fall into.

A pneumatic railway is proposed for Plainfield, N. J. According to the published description, the rail will be hollow, with connection with a compressor at the power station, which will force air at high pressure through the rail. All along the rails will be valves, eight to each circumference of the wheels, into which there will fit protuberances on the wheels which open the valves as the car passes, and the compressed air within the rail will be brought to act on the wheel just back of the point of contact, which the inventor claims will give the wheels a strong motion. The road is to be in operation by October, and it will connect with the electric street railway.

Several municipal ordinances have been passed by the Common Council, of Chicago, Ill. The Mayor recommends the passage of a general ordinance for the paving of all streets and alleys by special assessment within the district bounded by 22d St., the lake, and North and Center Aves., with the repaving of all that have been paved previously, but are now found to be out of repair. He indorsed the Swift ordinance for the establishment of the required number of crematories for burning the garbage of the city, favored the performance of the scavenger work by a plant owned by the city, urgently recommended the extension of the electric light system, and called attention to the advisability and necessity of requiring a general use of broad tire wheels for all traffic wagons in use within the city limits, as the narrow tires cut the streets to pieces and quickly destroy pavements. He omitted to recommend the cleaning and sprinkling of the streets by special assessment, but that may be included by the Council, covering as large area as may be deemed advisable, which will probably include all thoroughfares under the control of the municipality which are mostly likely to be used by visitors to the exposition. He mentioned incidentally that contracts have been left for increasing the Bridgeport pumping works, and that the city is now assured of a pure and ample water supply for next year. The Council has passed an ordinace for the extension of the North Shore tunnel to the two-mile crib.

A new fast train has recently been put on by the Philadelphia & Reading R. R., between Philadelphia, Pa., and Atlantic City, N. J., a distance of 56½ miles for which the schedule time is 70 minutes. Of this distance one mile is across the ferry from Philadelphia to Camden, which occupies about ten minutes, leaving 60 minutes for a railway run of 55½ miles, without stops. The train consists of eight cars, generally including a heavy Pullman car.

Storage battery electric motors are, it is reported, likely to be adopted by the Kings County Elevated Ry., of Brooklyn, N. Y. Gen. Jourdan, president of the company, is in favor of the change, and when the Brooklyn Bridge terminus is moved to Tillary St. the elevated road will make that point its chief terminus and run shuttle trains to Fulton ferry. The Second Avenue Street Ry. Co., of New York, has applied to the State Board of Railroad Commissioners for power to adopt electric traction by means of storage battery motors.

THE NEW WATER-WORKS AT PEORIA, ILL.

(With inset.)

The water-works at Peoria, Ill., were owned by the city previous to 1889. They were built in 1869, the Holly Manufacturing Co., of Lockport, N. Y., being the contractors. Rotary pumps were used at first, but were afterward replaced by direct-acting pumps. The supply was from an underground gallery built along the shore of the Illinois River. The walls of this became stopped up with silt and mud; after a time channels were cut through by the water, and for several years, it is stated, Peoria was supplied with Illinois River water, and the "filter gallery" was a favorite ground for cat fishing. The water could not be used for domestic purposes, and the people were forced to rely on cisterns or on spring water delivered in cans or jugs for water for cooking and drinking. In the spring of 1889 the city contained about 40,000 people, and had so far outgrown the old works that a new system with a new supply was a necessity. The city was at the legal limit of bonded indebtedness, and therefore unable to make the necessary improvements needed. It was decided to ask for bids for a franchise. Moffett, Hodgkins & Clarke, of Syracuse, N. Y., were awarded the franchise, and the Peoria Water Co. was organized and took possession of the old works. Mr. Chester B. Davis, M. Am. Soc. C. E., of Chicago, was engaged to make the surveys and examinations, to prepare the plans, and to act as consulting engineer. Mr. W. C. Hawley, Assoc. M. Am. Soc. C. E., was principal assistant engineer to Mr. Davis. We are indebted to Mr. Hawley for the information given herewith.

It was found necessary to practically build a new system. Work was begun early in 1890.

The old system was a direct pressure system. When the new company took possession the pumping plant had an aggregate daily capacity of about 5,000,000 gallons, and consisted of one compound and one simple duplex condensing Worthington; a Deane and a Cameron. They were in fair condition, but were being overworked, and the Cameron and Deane were pounding badly. The pipe system had been laid out without regard to future extension, and over 25% of it had to be taken up and relaid. There were very few valves in the system; some right and some left handed, and no record of them whatever. Many of the hydrants were out of repair. The record of taps and fixtures was inaccurate. A house-to-house inspection and a liberal use of meters made a material reduction of the daily amount pumped, and allowed stoppage and needed repair. The old pumps were used until November, 1891, when the new ones were started.

The ordinance granting the franchise outlined the new system, and this explains, Mr. Hawley states, some features which would hardly be considered good engineering; for instance, a pumping capacity of more than 21,000,000 gallons per 24 hours where two 5,000,000-gallon pumps would have been ample.

The new water supply is taken from an underground stratum of sand and gravel, which extends from near the "Free Bridge," about three miles northeast of Peoria, for several miles along the river bottom, running back under the bluffs on either side. There is a layer of about 20 ft. of clay above it. It is stated by Mr. Hawley that it was proved conclusively that this supply has no connection with the river. The water is pure and fit for all uses. The pump station and well are located about three miles from the center of the city, and 700 ft. west of the river. The well is 36 ft. in diameter, lined with a 30-in. brick wall, and was sunk on a wood and iron shoe to a depth of 44 ft. During construction, from May to October, it was necessary to pump continuously, and from 11,000,000 to 13,000,000 gallons a day were taken from this well.

A 30-in. main runs from the pumps to the center of the city; thence to the south city limits are a 20-in. and a 12-in. main on parallel streets. Near the north city limits a 16-in. main branches from the 30-in. and runs up over the bluffs connecting with the two stand-pipes; thence diagonally across the southern part of the city connecting with the 20-in. and 12-in. mains. There are several 12 and 10-in. mains connecting the 30 and 20-in. with the 16-in. main, and the system is still further subdivided by 8-in., 6-in. and 4-in. pipes. There are about 80 miles of pipe, not including hydrant branches. There were about 43 miles in the old system; of this 11 miles were taken up and relaid, and the balance is new pipe. There are 1,000 hydrants in the system, of which 10 are six-nozzle, and 100 are four-nozzle (one nozzle for steamer connection). The balance are two-nozzle. There were 374 hydrants in the old system, but some of them had to be replaced. An intermediate valve is placed between the hydrant and the main in each branch taken from an 8-in. pipe or larger. There is an abundance of valves in the system, about 1,000, including those on hydrant branches.

A reproduction of a photograph of three 7,500,000-gallon Worthington high duty pumping engines was given in our issue of June 23.

Fig. 1, on the inset, shows a section and details of the chimney. Further details of the pumping station will be given in a later issue.

About 1,000 ft. from the pumping station a 30-in. main branches from the city main, and runs north about a mile to a reservoir with a capacity of 18,000,000 gallons, with the flow line at grade 320. This gives a head of 220 ft. at the court house, in the center of the city.

The reservoir is irregular in plan, as shown by Fig. 2, on the inset. A section through the center of the reservoir is shown by Fig. 3, and a detailed standard section through the embankment by Fig. 4. In this section a brick heart-wall of uniform thickness is shown, but Fig. 5 shows a concrete heart-wall, stepped from a thickness of 3 ft. at the bottom to 1 ft. at the top. Fig. 5 also shows the junction between the foot of the embankment and the natural earth. Instead of ramming gravel into the clay bottom, as originally intended, the whole was paved with from 4 to 6 ins. of concrete.

The force main passes through the gate-house shown by Fig. 8, extends across the reservoir, and terminates with a check valve, as shown by Fig. 6. As the influent and effluent pipe is the same, a T ending in another check valve, see Fig. 7, branches from the force main just after the latter passes through the bank. Water is drawn from the reservoir at this point, thus insuring a circulation. Water can be entirely excluded from or held in the reservoir by means of the valve in the chamber shown in Fig. 8 and on the plan. By referring to Figs. 8 and 9 it will be seen that the gate chamber is of brick, circular in plan to the top of the embankment, then octagonal, with a tin roof. The overflow of the reservoir is shown by Figs. 8 and 9. It is connected with the force and supply main, and, like the main, is 30 ins. in diameter. A 30-in. waste pipe is provided to drain the gate chamber and a 10-in. mud pipe leads from the reservoir into the gate-chamber.

The waste pipe is supported on brick piers founded on concrete, as shown in detail in Fig. 8. From Figs. 6 and 7 it seems that the force main across the reservoir is supported in the same way. The part of the gate-house above the embankment is shown by Fig. 9 and needs no further description.

There are two stand-pipes in the city. The one on the "East Bluff" is 30 ft. in diameter by 85 ft. high. The bottom course is of 5/8-in steel (66,000 tensile strength); the thickness of the courses diminish to the 12th, which is 1/4-in. steel; and the 13th to 17th courses, inclusive, are of 1/4-in. wrought iron. The stand-pipe on the "West Bluff" is 25 ft. in diameter by 120 ft. high. Bottom and second courses are of 3/8-in. steel; 18th course of 1/4-in. steel; 19th to 24th of 1/4-in. wrought iron. The foundations are of concrete, and similar to the one under the Des Moines, Ia., stand-pipe, which was described in Engineering News of April 9, 1892.

Details of the valve chamber of the stand-pipe are shown by Fig. 10 and of the cast iron manhole cover and device for locking it by Fig. 11.

Fig. 12 shows in detail the "holding down bolts" and plate used to anchor the stand-pipe to the foundation. Fig. 12 also shows the connections between the force main and stand-pipe. A vertical iron ladder gives access to the balcony which extends around and near the top of the stand-pipe. The balcony and its details are shown by Fig. 13.

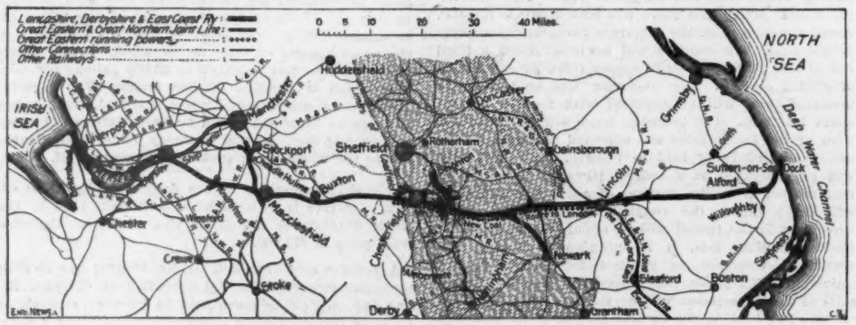
The stand-pipes were built by the Porter Manufacturing Co., of Syracuse, N. Y. The valves and hydrants were furnished by the Ludlow Valve Co. The pipe and specials were from the Lake Shore and Addyston Pipe Foundries. The works were built by the Moffett, Hodgkins & Clarke Co., of New York City, with E. H. Burlingame (who is also the president), Constructing Engineer; Eugene Carroll, Assoc. M. Am. Soc. C. E., Principal Assistant Engineer and J. A. Harmon, Second Assistant. Mr. W. H. Fritchman is Secretary and Superintendent. The total cost of the works was about $2,000,000. Mr. Hawley states that the test of the works was made Saturday, June 4, and was entirely satisfactory. Thirty streams were thrown simultaneously through 1-in. nozzles to heights of at least 100 ft. vertically in the portion of the city below the bluffs; and on the bluffs 10 streams were thrown simultaneously to a height of 75 ft. vertically. Prof. J. B. Johnson, of St. Louis, who represented the city at the test, is reported as expressing himself as very much pleased with the whole system, and as pronouncing it one of the best and most complete in this country.

AVELING & PORTER'S ROAD ROLLER WITH COMPOUND ENGINE.

We illustrate herewith a steam road roller built by Messrs. Aveling & Porter, of Rochester, England, fitted with compound engine. The application of the compound principle to steam road rollers was taken up about a year ago by Messrs. Aveling & Porter, and three rollers with compound engines are now in service and giving excellent satisfaction. The saving in fuel compared with road rollers fitted with the simple engine has been found to be from 20 to 30%. As with the compound locomotive, the saving is probably due quite as much to the softer exhaust of the compound as to the more economical use of steam. A road roller, however, uses a very small amount of fuel in any event, and the saving in the cost of fuel is among the minor advantages secured by the use of compound cylinders. The gain of most importance results from the fact that the steam passes through the exhaust nozzle at much lower pressure than with the simple engines. This makes the compounded roller much less noisy than the ordinary type and much less likely to frighten horses. The throwing of fire is also largely reduced, the wear on tube-ends is less, and the fire-box plates last longer on account of the less severe duty exacted by the furnace.

Another advantage of the compound over the single cylinder engine is that it has no dead-center, and can be started with the cranks in any position.

The 15-ton roller has cylinders 5 and 9 ins. in diameter. As seen in the engraving, the two cylin-



MAP OF THE LANCASHIRE, DERBYSHIRE & EAST COAST RY.

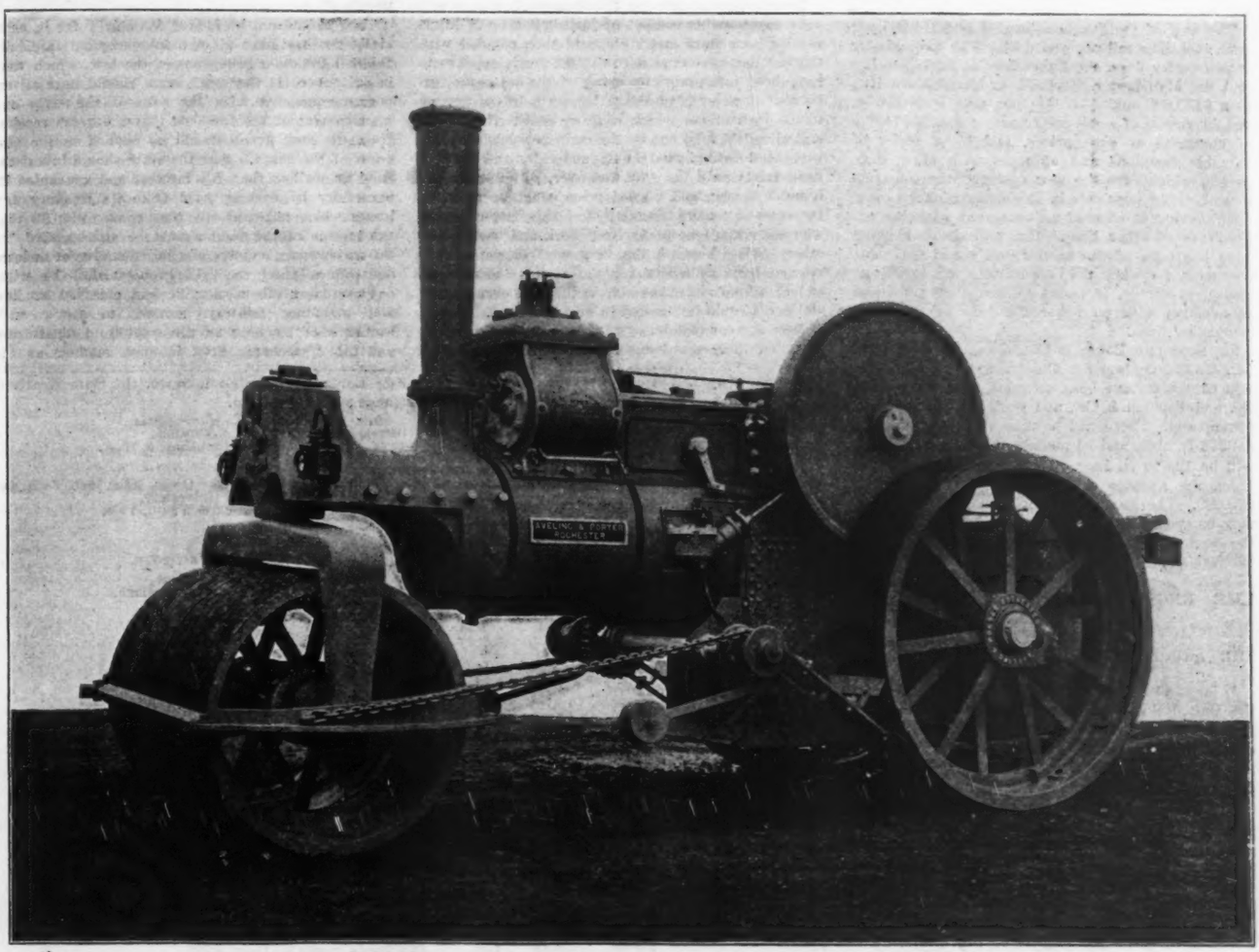
(See Page 27.)

ders are mounted side by side on top of the boiler. They are thoroughly jacketed with live steam, and take their supply from the jacket. The cylinder casting, in fact, forms a steam dome for the boiler.

Some other improvements which our cut does not show have recently been introduced on the Aveling & Porter rollers. Among them is a new system of wheel scrapers which does away with the use of counter balance weights, and is expected to make the breakage of the scraper well nigh impossible.

A rearrangement of the back transverse plate, the side plate brackets and the gearing has been made, so as to give more room on the driver's foot plate and easier access to the fire-door. The usual steerage drums have been dispensed with, and a single corrugated shaft with an endless thread has been substituted, making a simpler and more desirable winding drum.

Mr. W. Churchill Oastler, C. E., 43 Exchange Place, New York City, is Messrs. Aveling & Porter's authorized representative.



ROAD ROLLER WITH COMPOUND ENGINE. Aveling & Porter, Manufacturers.

AN EAST AND WEST COAST RAILWAY FOR ENGLAND.

The railway system of England is so complex and so nearly complete that there is comparatively little room for new trunk lines of any great length, and it is said to be 20 or 30 years since the last trunk line was authorized. The new lines built year by year are principally connecting or branch lines to increase existing facilities or to afford improved accommodation to certain districts. It may be noted here that there is still quite an extensive field open in England for light railways of small cost, to develop the traffic and resources of agricultural and other districts now comparatively remote, but not for trunk lines.

This year, however, two large and important trunk lines have been authorized, and there is every prospect of their being constructed. One of these is the new line from London to Sheffield, which will be built by the Manchester, Sheffield & Lincolnshire Ry. as an extension of its system, and which will give London a new route to the north and another large terminal station (Eng. News, May 12). The second is the cross-country line of the Lancashire, Derbyshire & East Coast Ry., which was noted in our issue of May 19, and which is the longest line that has been authorized for some years. This railway will be 175 miles long, of which 160 miles will be the main line, and it will form an important connecting link between the east and west coasts, traversing the heart of the great Midland coalfield, and opening up a greatly improved communication between many of the chief centers of population and industry.

As shown by the accompanying map, the railway will run almost due east and west. Its starting point on the western side will be the docks at Warrington, on the Manchester Ship Canal; thence it will run practically due east to Sutton-on-Sea, on the Lincolnshire coast, where a new harbor and docks are being constructed. Warrington, with a population of over 50,000, and rapidly extending industries, will be a most convenient center, commanding the traffic of the Manchester Ship Canal, and being within easy access of Manchester, Liverpool and the cotton and coal mining districts of Lancashire and Cheshire. The section from Warrington to Knutsford will provide direct railway communication where none has previously existed, a junction being made at Knutsford with the Cheshire lines, over which the products of the extensive alkali and salt districts will be conveyed. Macclesfield has 40,000 inhabitants, is the center of the silk industry, and by its connection with the North Staffordshire Ry. system will present an easy outlet to "the Potteries," Birmingham and the "Black Country." In a northerly direction the line will obtain access to Stockport and Manchester by a branch joining the London & Northwestern Ry. at Cheadle Hulme, the Midland Ry. and the Cheshire lines at Heaton Mersey. At Buxton the new line will touch the tourist and pleasure and health-seeking traffic, and will afford ready communication between that fashionable resort and large districts which have hitherto had no railway communication with it. At Chesterfield it will tap the great Midland coalfields, and will therefore necessarily become a great coal carrying line for the immense productive area it will penetrate. These coalfields have an annual output of 17,500,000 tons in spite of inadequate railway accommodation, and this output is steadily increasing. The line will run for over 50 miles through the heart of the Derbyshire and Nottinghamshire coalfields, and for a large part of the route will be several miles distant from any existing line. The iron works in north Derbyshire will be connected with the line, and their freight traffic, as well as the coal already alluded to, will have the best route over the new line to the great depots of the Great Eastern Ry. Co. in the large manufacturing district of the east end of London, which at present have no direct communication with the coal pits. It is calculated that by the time the new line is completed the total annual output along its course will not be less than 10,000,000 tons, and facilities will be opened up both westward over its own road to Lancashire and Cheshire and by means of junctions with the Great Northern Ry. and Great Eastern Ry., not only to London but to the eastern counties, and to the port

of Grimsby. In addition to this, it is assumed that the new east coast dock, with first-class coal shipping appliances, at Sutton-on-Sea, will insure an export shipment of 3,000,000 tons per annum.

East of the great coalfield, the line touches Lincoln, a considerable iron and agricultural center, and thence runs direct to Sutton-on-Sea, where about $3,500,000 will be expended in establishing the east coast dock. The position is said to be excellently adapted for the site of a harbor, and a large trade is expected to be developed, not only in coal, but in fish and general freight. The above description will give some idea of the richness and importance of the route, the greatly improved trade and passenger facilities which it will bring about, and the impetus it seems likely to give to the industrial development of the districts through which it will pass.

The cost of the line is estimated at $214,285 per mile, including railway and dock. The two existing cross-country lines, the Lancashire & Yorkshire Ry. and the Manchester, Sheffield & Lincolnshire Ry., cost $430,000 and $370,000 per mile respectively, but, by reason of small preliminary costs, the letting of contracts at cash prices, and by a series of valuable junctions and alliances with other companies, which save the new company the construction of costly terminals in the large cities, an enormous saving is effected as compared with the expenditure of other lines. The attitude of existing lines has been of the most friendly and favorable character, for while the new railway will invade no special preserves, it forms mutually advantageous connections with no fewer than six of the great companies' lines.

Sir Benjamin Baker is Consulting Engineer, and Mr. R. Elliott Cooper is Chief Engineer. Construction contracts have been awarded to S. Pearson & Co. and Topham & Co., and work has already been commenced. There will be nine viaducts, the highest 272 ft. high, and 16 tunnels, the longest of which will be 12,630 ft. long. There will also be 28 stations, the average cost of which is estimated at $39,000. The line will be built in sections, which may be opened from traffic before the completion of the entire line. The company has a capital of $25,000,000.

THE ENGINEERING SCHOOLS OF THE UNITED STATES. *

XIII.

THE AGRICULTURAL COLLEGE LAND GRANT AND ITS MANAGEMENT.

A large proportion of the engineering schools of the United States organized after 1862 were more or less affected by the now well known Agricultural College Land Grant Bill, passed in 1862. While in many cases both the sale of the land granted and the funds derived therefrom were badly managed, in others the grant was productive of immense good. One of the causes which encouraged the formation of the Massachusetts Institute of Technology, for example, was the certainty of receiving a small annual stipend from this fund, and the New York grant, under the superb and exceptional management of Ezra Cornell, the founder of Cornell University, is to-day the principal support of that grand institution. The contrast between the administration of this fund by the several states is in many ways interesting and instructive, and constitutes an important part of the history of technical education in this country.

The full history of the fund is to be found in two pamphlet publications, one published by the Bureau of Education and purporting to give "The History of Federal and State Aid to Higher Education in the United States," and the second compiled by the attorneys for Cornell University giving a "History of the Agricultural College Land Grant of July 2, 1862," for use in a litigation then pending. As is too apt to be the case, the elaborate official publication is not nearly as complete on important points as the individual compilation, but we take some notes from each of them.

The original of the Agricultural Land Grant Bill was introduced in Congress by Hon. Justin S. Morrill, of Vermont, in 1858. Even in those troubled times the bill found friends enough in both houses to be passed by a small majority, but President Buchanan added another to his grounds for grateful remembrance by the American people by vetoing it, on what grounds we do not know. In 1862, however, in almost the darkest days of the war, the bill was again introduced by its author, passed easily after slight amendment, and became a law by President Lincoln's signature July 2, 1862.

The bill provided in substance that each state should be granted 30,000 acres of non-mineral public lands for each senator and representative in Congress, the land granted to be within the limits of each state if there were enough public lands within it open for sale at $1.25 per acre, or otherwise each state was to be given scrip, "which shall be sold" for the benefit of the state, but each state was positively prohibited from locating any of its scrip in its own name within the boundaries of any other state.

The obvious motive for this command was to prevent any possible conflict of jurisdiction or of interest between state and state, and this, coupled with the seeming command to "sell" the scrip, appears to have been interpreted by many of the states as forbidding them even to assign the scrip to trustees or to the institutions which were to benefit therefrom, and allow them to handle the scrip in a business-like way by locating good lands under it, and holding these lands until the war was over, settlements had become denser, and a good price could be realized. It seems the more singular that this latter course was not taken (except by New York and one or two other states) because the very next clause of the law contains authority for the state's "assignees" to locate land under the act, so that not over 1,000,000 acres could be entered in any one state. Nevertheless the command to "sell" was distinctly in the law, and there was some room for hair-splitting as to whether anything less than an absolute alienation of all title and interest in the lands would comply with the law.

There can be no doubt that this wording of the law was a mere inadvertence, and that there was no thought of impeding each state from so using its scrip as to realize the utmost possible sum for it, with the sole exception that no state as such was to acquire the title under the law to land in any other state. But there was at least room for dispute; the attention of the several states was then concentrated upon the war, the need of money was great, the future of the country was doubtful; above all, the easiest thing to do for the states which had no public lands within their borders was to conform to the letter of the law by throwing the scrip upon the market for what it would bring; and this they nearly all did.

They should not be judged too hardly for it, especially as they have all without exception faithfully fulfilled the other provisions of the law, which were in substance (1) that each state should bear all expenses connected with the sale of the scrip and management of the fund, so that the gross receipts from the land grant should be applied to the purposes of the act; (2) that the state should invest the fund at not less than 5% interest and guarantee its perpetuity by making good from its treasury any losses which might at any time come to it; (3) that the income of the fund should be appropriated "to the endowment, support and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and other mechanic arts, in such manner as the

Table Showing the Amount of the Agricultural College Land Grant to Each State, the Sum Realized Therefrom and Its Investment and Disposition.

State.	Acres granted.	Realized—Total.	Realized—Per A.	How invested.	To what college allotted.
Maine	210,000	$118,303	.56	State 5%	State Coll. Agr. & M. A.
New Hampshire	150,000	80,000	.53	State 6%	" " " " "
Vermont	150,000	135,500	.90	State 6%	" " " " "
Massachusetts	390,000	219,000	.56	R. R. bonds 5%	Mass. Agr. C. (⅔). Mass. Inst. Tech. (⅓).
Rhode Island	120,000	50,000	.41	Br. Univ. 5%.	Brown University.
Connecticut	180,000	135,000	.75	State mtges. in part	Sheffield Sci. Sch., Yale.
Total N. E	1,200,000	$737,800	.614		
New York	980,920	473,403 / 6,188,671	.53 / 6.30	State 5%. / Private invts.	Cornell University.
New Jersey	210,000	116,000	.55	State bonds 6%.	Rutgers College.
Pennsylvania	780,000	406,000	.52	State 6%.	Penna. State College.
Delaware	90,000	83,000	.92	State bonds 6%.	Delaware College.
Maryland	210,000	115,943	.55	State bonds, etc., 6%.	Md. Agric. College.
Total Middle	2,279,920	$7,382,417	3.23		
Total, ex. N. Y.	1,290,000	$720,943	.559		
Virginia	330,000	285,000	.95	State bonds 11%	Va., Ag. & M. Coll. (⅔) / Hamp. Inst. (⅓)
West Virginia	150,000	90,000	.60	U. S. P. R. R. 6%	W. Va. Univ.
North Carolina	270,000	125,000	.46	State 6%	N. C. Coll. Agr. & M. A.
South Carolina	180,000	191,800	1.07	State 6%	Univ. of So. Ca.
Georgia	270,000	243,000	.90	State 7%	Univ. of Ga.
Florida	90,000	155,800	1.73	State bonds 6%	State Agric. Coll.
Mississippi	207,920	188,028	.90	State bonds	Ag. & M. Colleges.
Alabama	240,000	253,500	1.06	State bonds 8%	Ala. Polytech. Inst.
Louisiana	210,000	210,000	1.00	State —%	Tulane Univ. of La.
Texas	180,000	209,000	1.15	State bonds 7%	Agric. & Mech. C. Tex.
Tennessee	300,000	403,509	1.34⅙	State bonds 6%	Univ. of Tenn.
Kentucky	330,000	200,000	.60	State bonds 6%	Univ. of Ky.
Arkansas	150,000	135,000	.90	State bonds 8%	Ark. Indust. Univ.*
Missouri	330,000	170,000	.52	State 5%	Univ. of Mo.
Total Southern	3,270,920	$2,830,628	.891		
Ohio	630,000	342,451	.54	State 6%.	Ohio State Univ.
Indiana	390,000	340,000	.87	State 5%.	Purdue Univ.
Illinois	450,000	450,000	1.00	City bonds, mortg's.	Univ. of Ill.
Michigan	240,000	600,000	2.50	State 6%.	Univ. of Mich.
Wisconsin	240,000	363,739	1.51	State 5%.	Univ. of Wis. ¼ mill tax = 71,654
Iowa	240,000	649,396	2.70	Mortg's 7%.	Ia. State Agric. C.
Minnesota	120,000	525,838	4.39	Mortg's 6%.	Univ. of Minn.
Kansas	90,000	501,426	5.57	City bonds 8%.	Kan. State Agric. Col.
Nebraska	90,000	39,505	.44	Not stated.	Univ. of Neb.
North Dakota	.....	.....	....	State by constitution.	
South Dakota	.....	.....	....	State by constitution.	
Total No. Cent.	2,490,000	$3,813,355	$1.53		
Colorado	90,000	112,500	1.25	Not det'd.	C. Agric. Coll.
Montana	.....	.....	....	.....	.....
Idaho	.....	.....	....	.....	.....
Washington	.....	.....	....	.....	.....
Oregon	90,000	93,935	1.03	Mortg's, 8%	Corvallis Coll.
California	150,000	771,687	5.14	State mortg's. in part 7%	University of Cal.
Nevada	90,000	95,000	1.05⅚	State bonds, 4%	Nev. State Univ.
Utah	.....	.....	.....	U. S. bonds 4%	....
Arizona	.....	.....	.....	.....	.....
New Mexico	.....	.....	.....	.....	.....
Total Far West	420,000	1,073,172	$2 56		

SUMMARY.

New England	1,200,000	$737,800	$0.614
Middle	2,279,920	7,382,417	3.03
Do. ex. New York	1,290,000	720,943	0 559
Southern	3,270,920	2,859,628	0.891
North Central	2,490,000	3,813,355	1.54
Far West	420,000	1,073,172	2.56
Total U S	9,507,849	$15,806,372	$1.60
Do., less N. Y.	8,607,920	.....	$1.07

* With $130,000 more of county and city funds in consideration of location.

Michigan, Colorado, Kentucky and Louisiana had no yet sold all their land in 1890, and the probable receipts from the lands unsold are estimated in the above table Colorado still holds nearly its whole land grant, which is estimated at $1.25 per acre, though the land which it has already sold has brought less than that sum. Eight of the newer States (and remaining Territories) had made no disposition of their land grant in 1890, and we believe most of them are still olding the grant.

legislature of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

Each state was also to provide within its borders within five years "at least one college" answering to the description of the act, and each one did so. We have compiled in the table on page 28 a column showing the institution in each state selected as a beneficiary of the act, and also a column showing the way in which the fund has been invested. In most cases the beneficiary was a single new agricultural college. In one state only, Massachusetts, the fund was divided between two institutions. In quite a number of cases, as New York, Michigan, Vermont, Connecticut, the handling of the fund in accordance with the act was wisely intrusted to some large existing university. As a whole, the letter of the law was faithfully fulfilled, but the spirit broken only by taking no pains to make the fund as large as possible by careful management.

How great and unfortunate was the loss from this negligence is at once revealed by the accompanying large table, which is rearranged and extended from the pamphlet compiled by Messrs. Halliday & French, attorneys for Cornell University. The information was obtained by addressing a letter to the treasurer of each state asking seven different questions as to the amount and disposition of the fund, for use in a friendly litigation then pending between the university and the state. This letter was dated Sept. 12, 1889. After some six months' delay the desired information was at last obtained from each one of the 38 states then existing. We rearrange the states in geographical groups, and add the columns showing the investment and beneficiary of the fund.

The showing of this table is certainly very striking. Out of the entire list of 38 states only 9 have so administered this trust as to obtain so much as the regular government price of $1.25 per acre for their land, and all of these, with the exception of New York, were states in which public lands were open to entry within their own territory. These states, in the order of the price per acre realized for the land, have been as follows:

New York	$6.73	per	acre	$6,063,474
Kansas	5.57	"	"	[illegible]
California	5.14	"	"	771,087
Minnesota	4.39	"	"	526,818
Iowa	2.70	"	"	649,395
Michigan	2.50	"	"	680,000
Florida	1.73	"	"	155,880
Wisconsin	1.51	"	"	365,[illegible]9
Tennessee	1.34½	"	"	403,500
Total for these states (covering 2,450,920 acres)				$10,633,800
Total for remaining 29 states (covering 7,117,920 acres)				$5,232,512

It should be added that Rhode Island made a noble effort to locate its lands advantageously, and failed only through the self-sufficient connivance of a subordinate government official, Mr. J. M. Edwards, Commissioner of the General Land Office, with a local ring of speculators. At least, this is the only conclusion to be drawn from the high-handed way in which he overrode the legitimate and timely efforts of Brown University (the assignee of the state) to locate its lands advantageously, on transparently unfair and insufficient grounds set forth in the pamphlet above named compiled for Cornell University. The final result was that Rhode Island, which otherwise stood a good chance of realizing as much as New York for its lands, realized less than any other state, or only 41 cts. per acre.

Excepting Rhode Island, as not greatly, if at all to blame for the small return from its land scrip, the states which threw it away for less than half of the "par value" of government land scrip, so to speak, or $1.25 per acre, were 11 in number (counting New York*), and in the order of their iniquity as follows:

Nebraska	44	cents	per acre.
North Carolina	46	"	" "
Pennsylvania	52	"	" "
Missouri	52	"	" "
New Hampshire	53	"	" "
New York	53	"	" "
Ohio	54	"	" "
Maine	56	"	" "
Massachusetts	59	"	" "
West Virginia	60	"	" "
Kentucky	60	"	" "

The remaining 19 states all sold off their lands for between 63 cts. and $1.25 per acre.

* For that small portion of the lands which had been sold under state administrations before Ezra Cornell took hold of their management.

The first glance at the table shows that the New England states, without exception, so far mismanaged their trust as to realize but a few cents an acre for their scrip: that the Middle states, with the exception of New York, did but little better: the Southern states but little better yet: and the North Central and Far Western states but little better yet, with the sole exception of six or eight states which stand far above all the others in the list in the considerable sum realized for their land.

On the other hand, New York stands far above even these states in the amount realized from its scrip. With but little more than 10% of the total scrip issued, New York managed to realize nearly half (42%) of the total realized from the entire grant. Had the remaining 37 states managed their trust as carefully and well as did the state of New York in the person of Ezra Cornell, they would have realized for the cause of technical education the princely sum of $37,931,989, whereas they actually realized only $9,204,897, or less than 16% of what they might have realized as well as New York; a dead loss of $48,727,092 from lack of business judgment and sagacity in the state legislatures.

For there was nothing very extraordinary, after all, in the price realized for the New York lands, $6.73 per acre. It is no higher than the average profit of the purchasers of the scrip in all the other states, probably, the only difference being that the other states permitted this profit to go to enrich individuals, while New York at last yielded to the petitions of Mr. Cornell and graciously allowed him to save it for the use of a great university.

It happened in this way: In 1865 numerous educational foundations were fighting to have this land scrip divided up among them, and seemed likely to succeed. Through the vigorous exertions of Mr. Andrew D. White (afterward president of the university), aided by Mr. Ezra Cornell, both of them then state senators, the effort failed, after Mr. Cornell had announced that, if the entire income of the grant were bestowed upon one institution located at Ithaca, N. Y., he would supplement its endowment by the gift of $500,000 from his private fortune. The generous offer was accepted by the state, and thus was founded Cornell University, which was incorporated the same year.

In that same year also most of the states received their scrip, and promptly threw it upon the market for what it would bring. It greatly overstocked the market, of course, and could not be easily sold for more than 50 cts. per acre. Mr. Cornell saw that this was a needless sacrifice, and in 1866 made a still more generous offer to the state, by which he agreed to pay the state 60 cts. per acre for the scrip not yet sold, with the added obligation, enforced by ample security, that the lands were to be sold by him within 20 years, and that whatever he realized for them above the price paid should be turned into the treasury as a "Cornell Endowment Fund," the income of which should be devoted forever to Cornell University. He at once entered zealously upon the great labor of this trust. In a few years he had located over 500,000 acres of pine lands in the West, principally in Wisconsin. The few land sales made hardly paid expenses and taxes. He died in 1872 (we believe), but Henry W. Sage promptly stepped into his shoes both as a manager of this trust and as a liberal benefactor of the university, with the grand result stated.

PASSENGER COACH "OHIO," BALTIMORE & OHIO R. R.

THE EARLY HISTORY OF THE BALTIMORE & OHIO R. R.*

(Concluded from page 11.)

While the improvements we have noted in the locomotives, and which we have traced down to 1830, were being effected, other departments of the work were progressing. April 1, 1832, the line was opened to the Potomac River at the Point of Rocks, a distance of 70 miles from Baltimore, and was regularly worked throughout by horse power. As already stated, it had been contemplated to effect with inclined planes the crossing of Parr's Ridge, the summit of which was 800 ft. above tide and the eastern foot of which was reached at about 40 miles from Baltimore. The placing of the machinery for working the planes was, however, deferred from year to year and the traffic carried across the ridge by horse power, until the development of the engines already described led to their being tested on the heavy grade of the inclined planes.

I have already mentioned that at the very outset work along the Potomac was stopped by litigation resulting in favor of the Canal Company; a compromise was sought and finally effected in the spring of 1833. The immediate difficulty was the passage of the several spurs of the Blue Ridge, which are cleft by the river with bold and rocky slopes, are first encountered by the road in the Catoctin Mountain, at the Point of Rocks, and continue at intervals for 12 miles to Harper's Ferry. The compromise arranged need not be considered here. It was onerous enough, but could not be avoided, and under it the work was completed to a point opposite Harper's Ferry by December, 1834. During these years of obstruction, authority had been obtained to construct a branch road to Washington, and in 1831, Mr. B. H. Latrobe was appointed an assistant and assigned to the reconnoissance. This was followed up without delay by a more definite and careful examination. Mr. Knight takes a most comprehensive view of what he says must become a great national highway. He urges that no grades exceeding 20 ft. per mile, nor any curve of less radius than 1,500 ft., or in extreme cases 1,000 ft., be tolerated if avoidable at any reasonable expense, so that light locomotives may make the run regularly in two hours, and indicates the possibility of a "message being made to pass the whole distance from Washington to Baltimore in one hour."

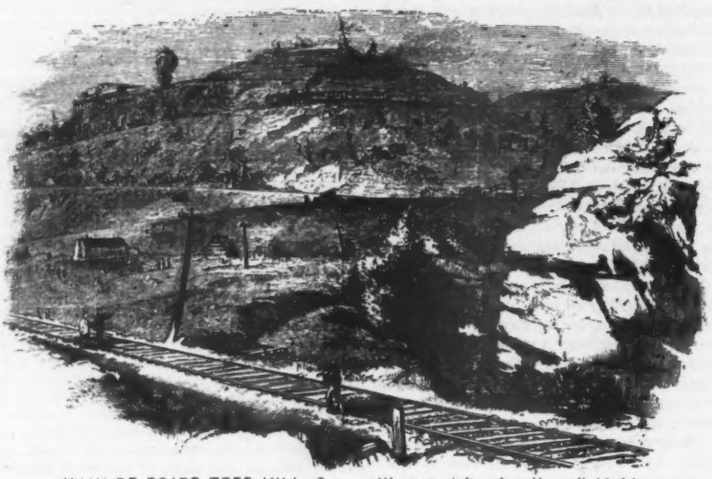
The surveys were continued with great minuteness so that, as the President expresses it, "the route finally adopted should leave no better one available to a rival corporation."

In July, 1833, Mr. Knight submits his report and analyses of twelve alternative lines with a degree of elaboration and care that I venture to say has rarely been equaled. The line recommended by him was at once placed under contract and under Mr. B. H. Latrobe, as the engineer in charge, was completed and opened Aug. 25, 1835. At its point of divergence from the main stem, seven miles from Baltimore, it crosses the Patapsco by a masonry viaduct of eight arches, each of 58 ft. chord, some 70 ft. in height above the water and of a total length of 707 ft. This was designed by Mr. Latrobe and stands to-day a monument to his taste and professional skill. The superstructure of the branch road was intended to be a great improvement on the various forms used thus far on the main stem. It consisted of longitudinal sills 6 ins. square and from 12 to 40 ft. in length, laid in trenches so cut for their reception that the upper surface of the sills will be from two to five inches below the graded surface of the roadbed. On this were laid cross ties 4 ft. from center

* Address of President Menden Cohen, at the Annual Convention of the American Society of Civil Engineers.

to center and cut out to receive stringer pieces of yellow pine 6 ins. square on which were laid the first heavy T rails used on the road. This rail weighed 40 lbs. per yd., as proposed by the Chief Engineer and modified in the shape of its face or surface by Mr. Ross Winans.

I must now say something of the progress made in

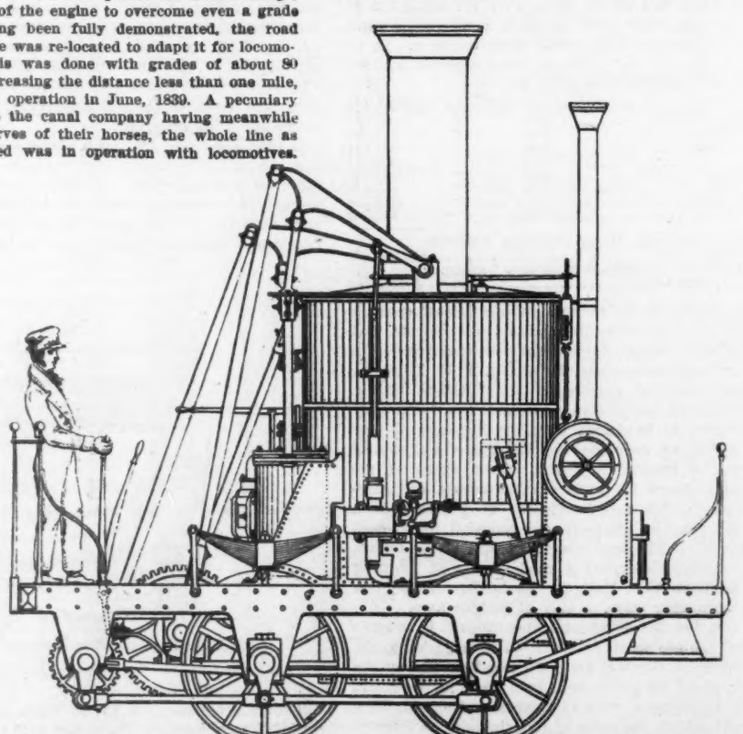


VIEW OF BOARD TREE HILL. (From "Illustrated London News," 1851.)

coaches, cars and car wheels. The coaches were at the outstart made about as comfortable as the stage coach of the day, and were built on much the same pattern; but, of course with cast iron wheels. The "Ohio," of which I am able to show you a lithograph, was an improvement on those which had preceded it. You will see that it is provided with Mr. Winans' anti-friction boxes. So long as horse-power alone was used nothing better was required. As soon, however, as the locomotive appeared upon the road, there came with it the necessity for modification in the carriages. The wheels, at first light to save weight, were made heavier, to give needed strength with increased speed. Mr. Knight improved the shape of the tread and flange, while John Edgar and Ross Winans developed its chilled features and Phineas Davis further improved and perfected the whole by altering the disposition of the metal in the tread and angle of the flange and by introducing within the wheel a wrought iron ring of ⅝ or ¾ in. round iron which, not only perfected the chill, but increased the strength of the wheel. So satisfied was Mr. Knight with the result that he observes at quite an early stage " the cast iron wheel has probably attained the utmost perfection of which it is capable." Thousands of these wheels were made at Mr. Winans' shops, not only for use in various parts of this country, but for some of the German and Swiss roads, which used them extensively up to 1851. Mr. Knight, in his report for 1836, states that the chilled wheels had run 30,300 miles and more at the high speed used on the Washington branch without the failure of a single wheel, and he had every reason to believe that 50,000 miles might be accomplished by them.

The increase of speed due to the use of steam made greater steadiness desirable in the coach than was possible in the four-wheeled car. The long stringers and sills for the track, some of them as long as 40 ft., had been heretofore carried over the finished road on two of the ordinary four-wheel platform cars coupled by a long pole. On the platform of each of these cars there rested transversely a bolster with a vertical pin, or king bolt, passing through its middle point and so connected to the platform of the car as to permit the bolster to swivel freely. On these bolsters of the two connected platform cars and stretching from one to the other, the track timbers referred to were laid. Vertical stakes secured to the ends of the bolsters prevented the timber from rolling off. This contrivance, a very familiar and natural one, and not even then used for the first time, answered its purpose perfectly and from its steadiness of motion suggested to the active mind of Ross Winans, the carrying of passengers on a car constructed on the same principle. His experiments soon followed and in the annual report of Oct. 1, 1833, the Superintendent of Machinery notes that he is building three car bodies to form one coach on eight wheels to carry 60 passengers. This was the birth of the eight-wheel car which was patented by Mr. Winans and, though the courts after long litigation decided adversely to his claim on the ground, I believe, of prior use, as in the case of the timber car and similar one for transporting large blocks of granite at Quincy, Mass., yet I have always believed that to Ross Winans we are indebted for this great improvement. Very soon thereafter eight-wheel cars were used throughout the line for both passenger and freight traffic and special cars were provided for baggage, which had theretofore been carried on top of the coaches.

I have stated that the road was opened to Harper's Ferry in December, 1834. The portion of the line crossing Parr's Ridge, located for inclined planes, with stationary engines at a maximum grade of 270 ft. per mile, was still worked by horses, as were also the 12 miles between Point of Rocks and Harper's Ferry. The latter section was so worked on account of the opposition of the canal company to the use of locomotives, because they frightened the canal horses. Trials of the new Davis engine, already described, having been made on the planes of Parr's Ridge, and the ability of the engine to overcome even a grade of 270 ft. having been fully demonstrated, the road across the bridge was re-located to adapt it for locomotive power. This was done with grades of about 80 ft. per mile, increasing the distance less than one mile, and was put in operation in June, 1839. A pecuniary consideration to the canal company having meanwhile steadied the nerves of their horses, the whole line as far as completed was in operation with locomotives.



"GRASSHOPPER" LOCOMOTIVE, BURNING ANTHRACITE COAL; WASHINGTON & BALTIMORE RY.

The increasing demand for these machines was partly met by replacing the engines at work on the Washington branch by others built by Mr. William Norris, of Philadelphia, having horizontal boilers and one pair of driving wheels of four feet diameter, with a truck in usual form, cylinder of 10½ ins. in diameter and 18 ins. stroke and weighing nine tons with 5½ tons on the drivers. It was a form of engine much better adapted to the fast passenger service of that line, and in its day a most efficient machine. These engines used wood fuel and were followed by others on the same general plan, using the same fuel, which was found less costly than the anthracite coal supplied to the Davis engines.

The crossing of the Potomac at Harper's Ferry was effected by a timber bridge, designed by Mr. B. H. Latrobe and built by Wernwag. It was a noted structure in its time, being modeled somewhat upon the plan of a celebrated bridge over the Rhine at Schaafhausen. A peculiarity of the line at this point necessitated a bifurcation of the bridge at its western end, forming two branches of a Y, the one arm connecting by a single span to the south with the Winchester & Potomac R. R., then just completed to meet it; the other by two spans to the west, being the prolongation of the main stem of the railroad.

This arrangement, involving the use of switches midway of the bridge, was necessarily somewhat complicated, but it has been continued to this day, although the rapidly increasing weight of the locomotives and trains caused the replacing of the timber bridge at a later date, 1852, by an iron truss, patented by Mr. Wendell Bollman, the details of which were arranged by Mr. J. H. Tegmeyer and which has been claimed as the first iron truss railroad bridge.

The extension of the line from Harper's Ferry westward to Cumberland, a distance of 96 miles, was now being pressed forward with his characteristic energy by Mr. Latrobe, the engineer of location and construction, and was opened to Cumberland in November, 1842. The engineering features do not call for special comment here, beyond reference to the track superstructure, which still adhered to the subsill. It consisted of a wooden under-sill and stringer piece with cross ties and blocks between them, the whole fastened by wooden pins. The iron rail was of the bridge form, weighing 51 lbs. per yd., with cast iron chairs at the ends and in the middle of the bars, which were held firmly down to the stringer piece by screw bolts at the ends and hook-headed spikes at intermediate distances. The whole rested on a bed of broken stone one foot in depth.

A marked stage in the development of the engines for this extension must now be noticed. In 1836 Ross Winans constructed two engines for the road with the Cooper vertical boiler and with the cylinders placed horizontally at the rear end of the frames and connecting by the spur wheel and pinion through the independent shaft to four driving wheels, as in the "Grasshopper" engines. This arrangement enabled the boiler to be depressed, and lowered the center of gravity of the whole machine some 12 ins., thereby giving greater stability at high velocity. This plan was further developed in 1842, in seven engines, built for the Western R. R. of Massachusetts, which had eight drivers instead of four. These were powerful machines, but were not a success. They were entirely unsuited to the use of wood, and as anthracite could not be furnished on that line at any reasonable price, the en-

gines were soon laid aside. On reaching Cumberland the Baltimore & Ohio tapped for the first time the bituminous coal region and a locomotive was wanted to burn that fuel. Mr. Winans, to meet this demand, designed an engine with horizontal boiler and horizontal cylinders of 16 × 22 ins., connecting with eight driving wheels 33 ins. in diameter through a spur wheel and pinion, as heretofore, and weighing 23½ tons. Of these engines, 12 were placed in service between 1844 and 1846, and were a great advance upon anything which had preceded them. They burned bituminous coal and handled the coal trade in its incipiency. They led the way in the development of the coal burning engine, the next step in which was the building in 1847 by Mr. Winans of four engines for the Philadelphia & Reading R. R. with horizontal boilers, horizontal cylinders, and eight driving wheels of 46 ins. diameter, the use of spur gearing being dispensed with. I mention these engines, for they have no equivalent on the Baltimore & Ohio R. R., and yet mark the stage to the next machine known as the "Camel." The first of this class of engines was placed on the road in 1848 in response to specifications prepared by Mr. Latrobe and limiting the weight to 22 tons. It had 17-in. cylinders of 22-in. stroke placed horizontally and eight 43-in. drivers; the firebox was larger and wider than ever before. In distributing the weight of this engine on its four pairs of driving wheels, it became necessary to remove the large dome from over the firebox to a point well forward of the middle of the boiler, where also the throttle valve and engine man were placed. This humped feature suggested the name "Camel," which was given to the first engine of this form, and the name has since adhered to the type. These engines were developed in the next few years by increase in size of boiler, firebox and cylinders, which latter were 19 × 22 ins. with a total weight of engine of 28 tons. They were most efficient and enabled the heavy grades of the new road west of Cumberland to be worked successfully. In fact they were designed for these grades, and there was no other engine then available for the purpose. This engine has been further developed and improved upon since, largely in the shops of the Philadelphia & Reading R. R., to which road many of them were supplied, where its crudities have been removed and its deficiencies supplied by the skill of the several engineers of machinery of that great corporation, notably by the late James Milholland and by Mr. J. E. Wootten; but many of its characteristics and important features can readily be traced—the horizontal cylinders, the large and wide firebox, the flat connecting and side rods; the latter arranged with fixed bushings incapable of adjustment, a feature much reviled at the time, but now recognized and adopted by the best builders.

The progress of the road beyond Cumberland was delayed for five or six years by many and peculiar causes. While the original charters granted by Maryland and Virginia were perpetual, yet there were limitations as to time of completion which were already exceeded and which now operated to require further legislation, while a limitation in the Pennsylvania charter operated to annul it altogether.

Maryland had a very large amount of money invested in the canal, which had not yet reached Cumberland, where it now rests, and still cherished the hope of its further extension, so that the railroad location must still be subservient thereto.

Virginia endeavored to couple with her grants of extended time onerous stipulations limiting the terminal point to Wheeling.

The railroad company would have preferred to locate its line to a more southern point on the Ohio, preferably to Parkersburg, at the mouth of the Kanawha, and was not insensible to the advantages of a terminus at Pittsburg, but was evidently averse to Wheeling.

The well known diplomatic skill of President Louis McLane had full scope in reconciling the difficulties, and with some measure of success, for though the act of Virginia of March, 1847, stipulated Wheeling as the terminus, yet the conditions were less onerous than certain earlier acts, under which the company declined to proceed.

It contained a section which seems to have been designed to facilitate connection with a branch to Parkersburg. This was so promptly availed of that the North Western Virginia R. R., now the Parkersburg Branch R. R., was well under way before the road was opened to Wheeling, and was completed a few years thereafter.

The definitive location of the whole line from Cumberland west was now pushed forward by numerous parties.

At the west end three alternative lines of approach to the Ohio presented themselves after avoiding the southwest corner of Pennsylvania, distant from Wheeling some 40 to 50 miles.

The first reached the Ohio at the mouth of Fish Creek, the most southern point permitted by the act of 1847, and then followed the river 25 miles to Wheeling.

The next touched the river at the mouth of Grave Creek, 12 miles below Wheeling.

The third, via Wheeling Creek, only reached the river at the city of Wheeling.

The first, although the longer, had light grades and no heavy work, and was the choice of Mr. Latrobe.

The second and third crossed several divides involving much heavy work, each of the two, including Board Tree Tunnel, of 2,300 ft. with 80 ft. grades on either side.

Wheeling, fearing an attempt to deprive her of the benefits of the actual terminus, protested against the adoption of the Fish Creek line as contrary to the spirit of the act of 1847 and a subsequent agreement between the city and the company. She called to her aid Jonathan Knight and Charles Ellet, Jr., as engineer experts.

Mr. Knight had resigned from the Baltimore & Ohio R. R. and had been succeeded by Mr. Latrobe in 1842, about the time of the completion of the road to Cumberland, and brought all the knowledge and skill acquired in the company's service during his 15 years' connection with it to bear in opposition to its plans and to the views of its Chief Engineer, his former assistant.

The situation may well have been embarrassing to Mr. Latrobe, whose notions of professional ethics were, I take it, of a different order.

It will be too long a story to enter here into the details of the controversy. It was skillfully managed on both sides. Reams of paper were filled with the calculations and discussions of the engineers and with the arguments of counsel, amongst whom were Daniel Webster, Reverdy Johnson and J. H. B. Latrobe.

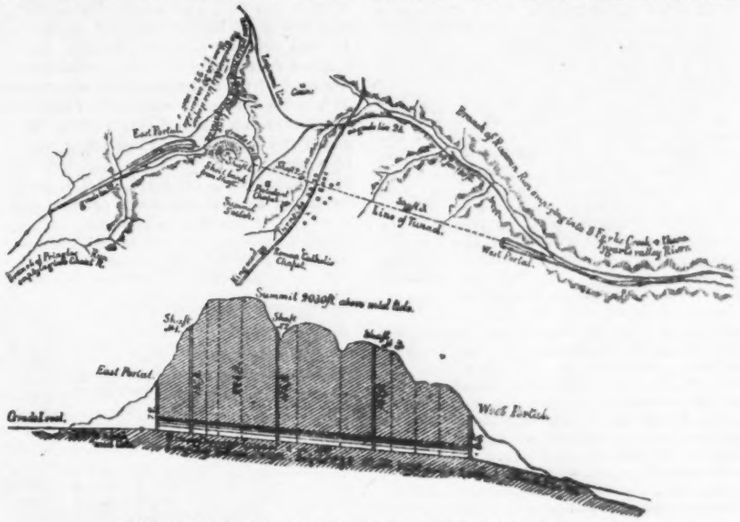
The matter was finally adjusted by arbitration in the autumn of 1850, resulting in the adoption of the Grave Creek line, having caused a further delay of three years.

The question of location having been settled, the construction of the 200 miles from Cumberland to Wheeling was pressed at all points with energy by able assistants, Wm. H. Small, George Hoffman, Thomas Rowles, James L. Randolph, George McLeod, Charles P. Manning, Benjamin D. Frost, Alfred F. Sears and Albert Fink, the latter a Past President of the Society, are names most of which are familiar to you.

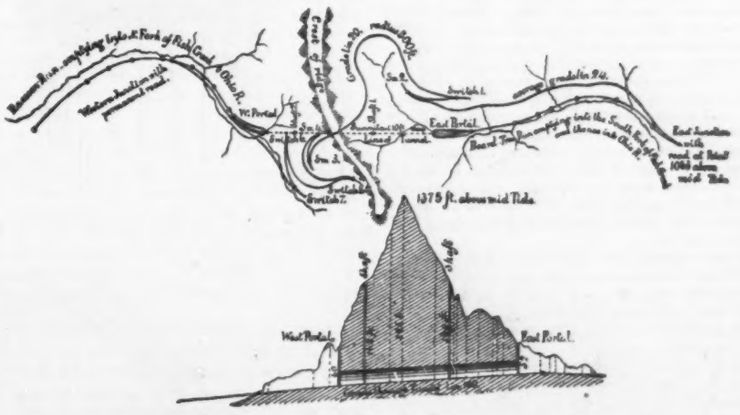
The track from Cumberland westward was laid throughout with 60-lb. rails on cross ties with a wrought iron H or lip chairs of boiler plate. The latter, though better than anything which preceded it, was very unreliable. The graded road was ballasted ahead of the track with broken stone, sand or gravel, as might be obtainable. The track was not yet perfect, but a great step in advance was made when there was no longer a subsill to churn away in the mud beneath a real or pretended ballast.

Mr. Latrobe's adoption of the 116-ft. grades in crossing the mountains was deemed bold and hazardous, but he had been trained in a school which was self-reliant. He made his calculations of what he required and what he felt sure could be accomplished, and found in Ross Winans the man who recognized the occasion and undertook the task of designing an engine that should perform the work. Well do I remember accompanying Mr. Winans on his first test of the new engine on the grade for which it was designed. The occasion was the opening of the new road in July, 1851, to Piedmont station, 28 miles west of Cumberland. Here begins the 116-ft. grade, which continues for 17 miles to the top of the Alleghany Mountains. The tracklaying force was busily engaged some three or four miles beyond, and this short distance was all that was available to see what the engine could do. As a test of its full power it did not amount to much, but there were attached to the engine, in addition to the passenger cars of the excursionists, a number of carloads of iron rails, all that were available, and with these the engine started at the foot of the grade and made its run at the rate of 10 or 12 miles per hour with a large surplus of steam, which was cut off at half stroke. On arriving at the end of the track with steam blowing off, there was much congratulation. It was realized that the question of ability to work this grade, of which great doubt had been expressed, was clearly demonstrated with a large reserve of power in the engine and from that time forward no more was said of impossibilities.

In the following winter and spring the track was carried to and across the slopes of Cheat River. Here the



PLAN AND PROFILE OF KINGWOOD TUNNEL; B. & O. R. R.



PLAN AND PROFILE OF BOARD TREE TUNNEL; B. & O. R. R.

deep ravines of Tray Run and Buckeye Hollow were crossed on grades of about 105 ft. to the mile, at an elevation of some 100 ft. above the bed of the ravine by trestle work, soon replaced by permanent structures, the detail of which was executed by our Past President, Albert Fink ,then assistant of Mr. Latrobe.

The next great feature was Kingwood tunnel of 4,100 ft. in length. This work not being ready in time to pass the track layers through without much delay, Mr. Latrobe determined to grade a track over the tunnel and passing the iron over it, to continue the work of tracklaying beyond. The maximum grade involved in this work was 10%, which, though intended for horse power, was worked by the "Camel" engine, which pushed over it one car of rails without any serious difficulty. At a later period, after the opening of the road, when the arching of the tunnel was in progress, this temporary line was revised with a maximum grade of 5% and the whole traffic of the road was carried over it for some months. The crossing of this tunnel effected, the progress of the road lay on easier lines for some 80 miles. The Monongahela River was crossed by a bridge of three spans of 200 ft. each. The masonry of the piers and the abutments of this bridge were intrusted to our late member, Mr. James L. Randolph, who was the division engineer the superstructure being designed by Mr. Fink. At Broad Tree Tunnel, about 164 miles west of Cumberland, was encountered another temporary delay by reason of the failure or inefficiency of the contractors. Here Mr .Latrobe again determined to avail of a temporary crossing over the top of the hill. This time the maximum gradient was 6%. The crossing was effected by a series of zig-zags, or switchbacks, two on one side of the hill and five on the other. The topography was such that there were two curves on the line of 180° and more of continuous curvature in one direction; the radius was 300 ft. Mr. Latrobe has himself so well described this crossing I will not repeat it here at length. This temporary road was most successfully worked for some five or six months. Beyond this point for 36 miles to its terminus at Wheeling there are no features of special interest which I now recall. The last rail completing the track to that point, was laid on the eve of Christmas, 1852, and early in the next month, January, 1853, the formal opening of the road to Wheeling took place.

And now ere I conclude an address which has, I fear, already taxed your patience, a word or two of the man who brought this great work to a conclusion.

Mr. Latrobe was identified with the Baltimore & Ohio R. R. almost from the very beginning. He had been intended for the law, but after completing his course of study, and being admitted to the Maryland bar, concluded that railway engineering was more to his taste.

He entered the service as an assistant to Mr. Knight, and I am quite satisfied that Mr. Knight, in all his career, never had a more faithful one. None could have been more loyal than he, and when he was no longer an assistant, but himself the Chief, his modesty was as marked as before.

Whilst his was the mind which planned and directed all, one might have supposed that the ideas emanated from the assistants, so ready was he to give them credit for their well executed details.

He took pride in the work with which he had been so long identified. He never could have accepted a retainer to oppose its interests, whether he was on its pay-roll or not. He left behind him in that portion of the Baltimore & Ohio R. R. which he built a monument to his professional skill, and in the hearts of his assistants, a loving remembrance not soon to be effaced.

REMOVAL OF A MASONRY PIER AT STETTIN, GERMANY.

This structure, which served as a drawbridge pier, was left standing in the Parnitz River, a branch of the Oder, within the limits of the city of Stettin, after the location of the existing railway line was changed from Stettin to Stargard. As it presented a serious obstacle to the increasing river traffic, it was decided to remove it, and on account of its location this had to be done without frequent blasting. The "Centralblatt der Bauverwaltung" gives the following account of the work:

The pier to be removed was built in 1840. Its exterior showed a facing of granite laid in hard Roman cement, and soundings revealed the existence of a course of sheet piling around the pier, with a protection of rip-rap at its foot. The original drawing of the pier showed a pile foundation. The specifications prescribed the use of the old course of sheet piling, shown at A on accompanying cuts, for the construction of the coffer-dam. Owing to the belief that the existing sheet piling, after having served such a length of time, would not be sound enough to permit of its use in the erection of a coffer-dam, local contractors could not be found, and the work was let to an outside contractor.

The preliminary work was begun by picking up the rip-rap around the foot of the pier with a claw-dredger mounted on a raft. Some of the stones weighed as much as a ton. The bottom of the river, after the rip-rap had been cleared away, was found to be covered with a layer of concrete, consisting of pieces of brick and cement. This was brought up in large slabs. The pier itself was found to be of rubble masonry, composed of irregular-shaped granite blocks with the interstices filled with bricks, laid in cement mortar. The single stones were detached and swung off by the claws of the dredger. Their average weight was about 1½ tons.

After the masonry had been pulled down to nearly the level of the water, a row of sheet piling, shown at b in Figs. 1 and 3, consisting of piles 7 ins. thick, was driven to a depth of nearly 10 ft. The space between the old and new sheet piling was filled with blue clay. To keep the interior free from water, two pumps were employed. After putting in the necessary bracing, the work of removing the masonry to the bed of the river was continued. A shell of the latter, however, was left standing. Then the timber platform on which the masonry had been resting and the layer of concrete below were taken out, exposing a layer of clay underneath. While attempting to pull one of the foundation piles a stream of water rushed through the opening thus formed, so that this plan had to be given up, and blasting was resorted to. To do this the tops of the piles were bored to a depth of 13 ft. and filled with 8.8 lbs. of dynamite each. The initial charges consisted of 10.6 oz. in air-tight canisters. The shell of masonry left standing, Figs. 1 and 3, received four cubical charges of 8.8 lbs. each. In all, 68 charges, consisting of 616 lbs. of dynamite, were used. The electric current for the blast was divided into three currents, each being attached to an induction apparatus. The blasting, however, did not prove to be as effective as was anticipated, owing to the dissolving action of the water, and several charges were taken out intact. The clearing away of the wreck was almost entirely done by the claw-dredges. The piles, which were split and loosened in their sockets by the force of the explosion, were pulled up by windlasses mounted on flat-boats.

The work of removing the pier lasted nearly nine months, and its cost was $8,700, approximately.

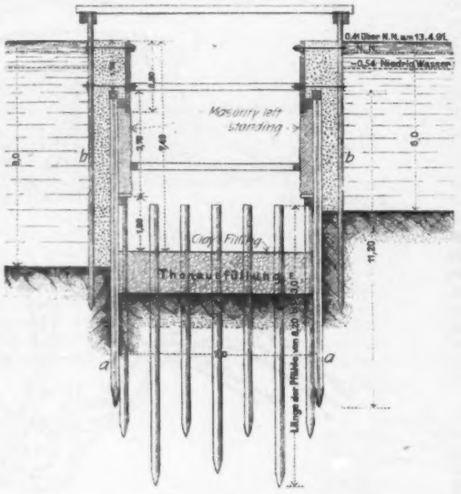


Fig. 1. Section, Ready for Blasting.

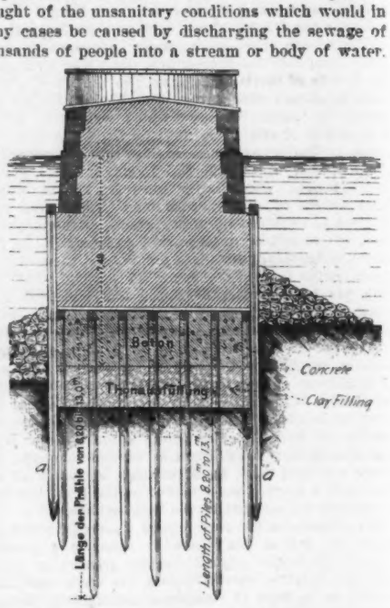


Fig. 2. Section, Original Pier.

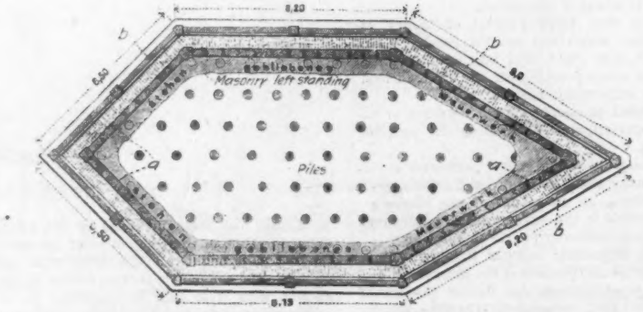


Fig. 3. Plan, Ready for Blasting.

REMOVAL OF MASONRY PIER AT STETTIN, GERMANY.

SEWAGE PURIFICATION IN AMERICA.

Introductory.

Among the many almost unworked fields of American engineering sewage purification is one of the greatest. The reason for this is evident. Until quite recently only a few American cities, and those the larger ones, had even an approach to a complete sewerage system. As new systems were built so much emphasis was placed upon the abolition of cesspools and similar nuisances that but few persons thought of the unsanitary conditions which would in many cases be caused by discharging the sewage of thousands of people into a stream or body of water. If only the sewage could be conveyed away from the premises of individuals and out of the town or to the outskirts of the town, even though discharged into a stream within the town limits, the majority of the people were satisfied.

The "self-purification of rivers" theory, or fallacy, tended to set at ease the minds of those few who raised the question whether the waters receiving sewage would not finally become fouled.

The work of the various River Pollution Commissions of England and similar work performed in Europe in later years, together with the development and gradual acceptance of the germ theory of disease, finally directed the attention of American sanitarians to the subject of the purification of sewage before its final discharge into natural bodies of

water. The American Public Health Association, a very few of the State Boards of Health, most notably the Massachusetts Board, and a few sanitary engineers have in late years been doing much educative work, and the engineers have presented some practical examples by constructing plants, all of which has resulted in a growing demand from the people for some improvements over old methods. To meet these demands some 20 towns in the United States have done something, though generally but little, toward purifying their sewage, and many more communities are discussing the subject.

The progress of sewage purification has been greatly retarded by the desire to find some method which would make a commercial success of the process. While such a result is highly desirable and its desire very creditable, attempts to secure it have not yet met with the success they have seemed to promise. Consequently some engineers and municipal officers dismiss the whole subject of sewage purification by saying, in effect, that no process has yet been devised which will pay its way, thus putting financial before sanitary considerations.

While sewage purification has been retarded as just stated, the same or a similar cause, apparently, has forwarded its progress in the West, where the demand for every available drop of water for irrigation has led to the use of the sewage of several towns for irrigation, according to the official reports which have been kindly furnished us.

The evident demand and need for knowledge on this subject, both among engineers and the general public, and especially the relation between sewage-polluted streams, water supplies and disease, have led us to undertake a thorough investigation and description of all that has yet been done in the way of town sewage purification in this country. Many of the plants, including most, if not all, of the best, have been or will be visited by a representative of this journal in order that their actual working may be observed. The results of these investigations will appear as rapidly as possible in these columns, the aim being to describe in as much detail as seems necessary each attempt to purify the sewage of a town and the results which are being obtained. The results can be stated only in a general way, as with very few exceptions the plants are too new to speak with certainty regarding their success, and in addition systematic observations of the work done are rare, with the exception of the analyses of the sewage before and after purification which are made by the Massachusetts Board of Health in connection with the plants in that state and the observations and analyses at the plant at Worcester, Mass.

Lenox, Mass.—Old Plant.

The first American town to undertake the purification of its sewage was Lenox, Mass., the noted summer resort in the Berkshire Hills, six miles from Pittsfield. A public water supply was introduced here in 1875, and the town showed its good sense by immediately constructing a sewerage system, built in 1875-6. Col. Geo. E. Waring, Jr., M. I. C. E., was engineer for the sewerage system, which is of the separate type. To these improvements, as well as its natural charms, the town doubtless owes a large part of its popularity as a summer home. The enterprise of the town is especially commendable, since its population, including that outside the village, by the census of 1880 was but 2,043 and by that of 1890, 3,120. In 1876 the population was considerably below 2,000, perhaps not more than 1,200. Hundreds of towns in the United States larger than the Lenox of to-day are still without sewerage systems, although they have had public water supplies and leaching cesspools for many years.

The village is located in hilly country, so that its drainage naturally flows in two or three directions. When the sewerage system was put in it appears that the larger part of the population was on the western slope of the hill, while the Housatonic River, the only stream in the vicinity large enough to receive the sewage of the town, was in a nearly opposite direction at the foot of a hill and some two miles away.

The sum available for the construction of the whole sewerage system, it is stated, was not large enough to construct an outlet sewer to the river, so some form of purification was necessary.

The increase of sewage overtaxed the plant, and the growth of the village in another direction finally made necessary a new disposal area, so that at present the original plant is only used for a limited number of houses and wholly for surface disposal. Nevertheless the plant is well worth describing, both in its past and present state.

The whole scheme can be best described by quoting from the engineer's description in his "Sewerage and Land Drainage," as follows:

> The plan finally adopted and carried out consists of several miles of 6-in. pipe sewers connected at their upper end, for flushing and for ventilation, with the rain-water leaders of such adjacent buildings as were available. The various lateral sewers, four or five in number, were connected with a single 6-in. main sewer leading for a distance of about 2,500 ft. to the upper edge of a field somewhat isolated with reference to present or probable building. It here discharges into a flush tank having a capacity of about 500 cu. ft., separated into two chambers by a wire-cloth strainer to hold back obstructing material. This tank is discharged by a Rogers Field's siphon into a smaller chamber having two alternative outlets; one leading to a system of subsurface irrigation-pipes aggregating 10,000 ft. in length, and the other to a surface-carrier for the disposal of the outflow over the ground should a portion of the tiles become obstructed. The main sewer leading to the tank has also a branch outlet by which the direct flow may in case of need be turned on to the ground.

In the work from which the above quotation is taken Col. Waring states that there was much irregularity of distribution through the "absorption drains," the connection between the discharging main and distributing tiles often becoming clogged by the lodgment of a piece of paper or a rag over the opening. The connection, Col. Waring states, was formed by inserting as a part of the discharge main a short length of iron pipe having elbow connections from its bottom so that the full force of the flow should come directly into the elbow connecting with the tiles. These connections were finally changed to a more approved pattern, but apparently not for several years. By such clogging as has been described Col. Waring states that one line of drains would sometimes be cut off and rendered useless for weeks at a time. This seems to explain the fact that the whole sub-surface plant, after the first two seasons of use, was frequently entirely or nearly clogged so that a resort to surface disposal and an overhauling of the connections was often necessary. It would seem, however, that the strainer in the flush tank should have removed such obstructions.

After ten years of use the drain pipes were replaced by new ones laid on gutter pieces, the new pipes being nearer the surface and midway between the lines of the old ones. The drains were 6 ft. apart and the soil is not adapted for sub-surface disposal.

For the past few years the sewage has been discharged entirely upon the surface, much of the solid matter being removed by settlement in a tank. This sludge is now thrown into a pit and covered with earth. The liquid matter passes from the tank through a ditch, from the lower side of which it overflows and spreads over the surface of the ground, causing a rank growth of grass for some distance below the ditch and for from 10 to 20 ft. above it.

This tract of land, some 1½ acres, is about ¾-miles from the center of the village. There are but two or three houses near by. At present about 20 houses discharge into the sewer leading to the land, and in the height of the summer season these houses contain about 200 persons. Before the new plant, described further on, was built the sewage from the population of about 700 was brought to this disposal area.

The writer went over this disposal area on a hot June day. No odor was noticed on the land receiving the sewage and only a slight odor along the ditch.

The town recently voted $5,000 to improve the disposal plant just described, and Col. Waring recently visited Lenox to look over the ground.

The sewage from four houses flows to a tank in another part of the town, from which it is discharged upon the natural surface of the ground. In the past six houses have been connected with the pipe line to this tract.

(To be continued.)

THE COMING DEVELOPMENT OF ELECTRIC RAILWAYS.

(Concluded from page 21.)

But if using a motor ahead of a train then there will be comparatively little difference in the stopping power.

When riding at 60 or 70 miles an hour, it is a very quick stop to bring a train to rest in less than 2,000 ft. This is often as far as any signal can be made out, especially when the weather is at all thick. Hence we may expect to find on electric railroads, if high speeds are to be attained, and quite possibly also on steam railroads, an extension of automatic signaling so that trains indicate on more than two sets of signals. At present the practice is to divide the line into sections, and when a train passes a certain point it sets danger and cautionary signals, dropping the danger signal on the section just preceding, and the cautionary signal on the one beyond.

Turning now to the greater powers, we must not confuse the terms "large powered" and "trunk line" work.

If we had a continuous train movement completely occupying a track system, there can be no question but that its operation from a central source by electricity would be more economical than if operated by steam locomotives. So, too, if a large number of units in reasonable proximity are moved, and the stopping and starting so regulated that the total demand upon the central stations is fairly continuous and equal, then there is no question as to economy of electric propulsion as compared with steam.

On the other hand, the operation of a single or a very few units over a long distance would be so uneconomical and afford so small a return on the investment required as to make it prohibitory.

Between these two lies the condition of operation where steam and electricity meet on planes of equality; as the number of trains decreases, steam operation is the more economical; as the number increases, electricity must be preferred.

Every system has its limitation. The electric is not exempt from this law, and hence it will set forth what are well known limiting laws concerning the transmission of energy. They have been stated time and time again, but people often lose sight of them in discussing the question of investments in large electric railways, so that I think it would be well perhaps to restate them and emphasize them.

The weight of copper necessary to transmit a given amount of power with a fixed loss will vary inversely as the square of the electromotive force used.

The distance to which it can be transmitted with a given weight of conductor will vary directly as the pressure.

The distance to which it can be transmitted over a conductor with a given cross section will vary directly as the pressure.

The weight of copper necessary where the supply station is in the center of a system is only one-quarter that required if the station is at one end.

The weight of copper will vary inversely as the square of the number of supplying stations properly placed.

The electromotive force required will vary inversely as the number of stations.

Lack of knowledge of these simple and unalterable laws have led to much misconception of electrical possibilities, and these have not been confined to the electrical engineers.

Leaving out of present consideration trunk line work, there are three problems requiring solution in the application of electricity to propulsion on a large scale for terminal and rapid transit work.

The development of an electric locomotive of ample power which shall be as readily controlled as the steam locomotive, and shall be reliable in operation, and shall show a high economy. Of course such a machine must have all the adjuncts which are necessary for train movement.

2. A system of conductors and method of supporting the same which can be relied upon for ample supply of current and absolute certainty of continuous contact at all speeds on curves, switches, cross-overs and the multitudinous combination which exist on yard tracks.

3. A system of automatic block signaling, which while effective for steam traffic will not be thrown out of operation by the use of tracks as conductors of electricity for a general supply. This is a more serious question than is at first considered, for this use will materially interfere with if not absolutely destroy the utility of what is known as the rail circuit system.

While I am not thoroughly familiar with automatic signaling, I believe that there is none at present existing which will meet all the requirements of railway practice, and which can be operated on tracks used by both steam and electric locomotives, where the rail is used as a part of the supply circuit. Some of the best known systems of signaling would be rendered entirely inoperative.

Difficult as it may seem to devise such a system, I believe that it certainly can be developed, but only properly so on a section of track which is more or less ex-

perimental; on which at the time of operation automatic signaling is unnecessary, but which is actually operated by both classes of service. Such an experimental section would be a combination of single and double tracks, with all the varieties of curves, crossings, switches and ladders, such as would be found in any large yard.

It will probably be found necessary to erect a variety of kinds of conductors. From the most careful consideration which I have been able to give to the subject, I believe there is one way, and only one way, in which the current can properly be supplied in any complicated system, and that is from the overhead conductor, practically rigid in character, following very nearly the center line of all tracks and switches with no movable overhead parts, and with return through the rail. The locomotive would then practically be moving between two electric planes, the lower being the guiding one. There has been a great deal of talk about other possible systems of supply; of the charged rails using low potential currents supplied at frequent intervals by motor generators driven from a central station. Since we have discovered no conductors devoid of resistance, and the art of welding is not particularly applicable for railway service where moving contacts are a necessity, little credence need be given to any scheme of this character.

We hear also of central rails supported on posts in wells between the tracks. A center rail may be acceptable on a system like that of the elevated railroads, but in ordinary work any ditch intended to drain a track so as to keep insulators dry and keep snow away from them would probably so open the track that any moisture and frost would cause upheavals of serious character, and the cost of maintaining the track would be prohibitory. The use of snow machinery for keeping the track clear would be impossible.

Another proposed system is that of conductors supported on posts alongside of the track and elevated but three or four feet above it. While not open to so serious objections in the matter of insulation as a center rail system, its use is manifestly not to be thought of where there are crossings or switches. Even on a straight clear track in a hard climate there would be most serious trouble in the matter of clearing the tracks from snow, and at the grade crossings in this country gaps in the conductors would be too great for the contacts on a single locomotive to stand.

Some time ago I was requested on behalf of a well known financial man, whose enthusiasm as to the possibility of electric traction is well known, but who is withal a most practicable railroad man, to inspect various railroad terminal tracks in this city with a view of, first, the substitution of the switching work now done by a part or all of the 1,800 or more switch engines by electric motors, and eventually the operation of suburban service.

Considering the railroads nearly as they exist on a number of systems in Chicago in the space of 1½ miles in length by ¾ mile in breadth, it is no exaggeration to say that there is or will be not less than 75 miles of track and switches and crossings with the various combinations almost innumerable.

I went over and over some of these tracks with the one thought in my mind: How can the current be delivered to the locomotives, and how can the automatic signaling be done? And I was forced to the conclusion that the overhead system of supply is the only one, but that it must be as substantial and thorough in character as that of any part of the system, and that in view of the cost, such a system is only permissible where the number of units operated is large and continuous.

Intimately connected with the question of conductors, and one of the most serious ones which has to be met by the electrician, is that of potential. The personal danger limit of continuous or ordinary period alternate currents is pretty well determined, and it seems generally admitted by constructors that the danger limit for the continuous current machine, with its commutator, is about the same as the personal danger limit.

Hence we meet with two dilemmas. If using continuous current motors, we are limited to a difference of potential per machine of 1,000 to 1,200 volts, and we can, so far as safety of the machines is concerned, only go above this limit by putting the motors in series, precisely as has been proposed for long distance stationary transmissions. If this is not done then we have the introduction between the transmitting dynamo and the receiving motor of a motor generator system, another pet theory which is often suggested, but which I unhesitatingly pronounce as so uneconomical as to be impracticable.

If using an alternate current system, then converters must be used, either distributed along the line and supplying the working circuit or placed upon the locomotive to safeguard the motors. While the use of a converter under these conditions is not as objectionable as the use of a motor generator, it is not a very practicable scheme.

For the present, and I think for a long time to come, we must confine ourselves to cases where continuous currents are used, and where the traffic between two points is sufficiently large to justify the investment in central stations and conductors which would be required.

There are two methods of propelling trains electrically, one by following steam practice, that is, by building a motor and hooking it to the head of a train, the weight of the motor being such as required for the necessary power and traction when grades or slippery tracks are encountered. From all that has been developed up to the present, to get control that is necessary and to build the machines safely, the electric locomotive will weigh nearly as much per horse power as the steam locomotive. This weight can be better distributed, but I do not think if steam practice is followed on trunk line service that there could be any very material reduction of weight of train.

The other plan is to have each car propelled by one or more motors. This would be the ideal system so far as propulsion goes, provided the electric motor was unlike all other mechanical apparatus, and that it never failed, and if a number of machines could be as well taken care of, cost no more and show as little depreciation as fewer machines of larger capacity operated as a unit.

Should we ever arrive, as we hope, to possession of a single circuit alternate current motor, then in view of the simplicity of its control we may fairly hope for the distributed motor system. But here also the capacity and likewise the weight of the motor being determined by the total duty done, the weight of train limit would not be decreased, but rather increased.

If, on the other hand, single units are used, the query naturally arises, what form would the electrical locomotive of the future take? I do not think this is by any means settled; undoubtedly gearless machines will be used, but whether they will be mounted directly upon the axle, or whether they will movably inclose the axle and be flexibly connected to it while their weight is carried on springs on the truck, or whether the motor will be carried on the truck frame and connected to the drivers by the ordinary coupling rods, are questions yet to be determined.

Whatever method of mounting the motor is adopted, for reasonable weights and powers, a two-axle truck will be used. Where large powers and weights are necessary, two such trucks will be coupled together so as to keep the weight upon each wheel within limits, and this will carry a cab containing the regulating and collecting devices, and so shaped as to offer the least resistance to air pressure and high speeds.

Among the roads that are ripe for the electrical engineer, and on which in the near future I hope he will demonstrate he has a most legitimate claim, are the New York and Chicago elevated lines, the handling of the trains on the New York Central and Harlem roads below the Harlem River, the long talked of rapid transit road of New York, the Metropolitan underground road of London, the proposed tunnel roads in London, Paris and Berlin, and coming more immediately home, suburban service such as that of the Illinois Central Railroad, a most ideal track for the electrical engineer, and last, and as it will prove, one of the most important, the operation of the terminal and warehouse systems for the interchange of freight on the lines entering a city situated as is Chicago.

Taking the last, we have here a definite problem, now performed in a more or less satisfactory way by steam service. It is a problem large enough of itself. It has little connection with electric trunk line service, and the present impracticability of the latter has little bearing upon the thorough practicability of the former; 1,800 or more switch engines, many of them on duty 24 hours a day, a large portion of the time standing idle, puff their foulness into your over-burdened atmosphere, because from 80 to 90% of all the freight that comes into the depots of this city ought never to come inside its limits and would not were there a practical way provided to distribute it from one road to another outside the city limits. It has been suggested, and it seems to me a most feasible plan, that there shall be established a vast system for interchanging freight on the various railroads by a great 6-track crossing belt road, which shall form a common zone of transfer either by itself or in combination with freight warehouses or storage yards. From an electrical standpoint there is absolutely no question but that such a system of belt line is practicable.

I have fortunately or otherwise been thrown into a direct touch with all the larger work which is to be done in this country during the coming year, and it gives me pleasure to announce, what many of you know from the current news of the day, that there will probably be in operation in the United States within a year not less than five locomotives varying from 700 to 1,200 HP. and from 45 to 80 tons in weight. The character of the work done will vary. In that work with which I am most concerned personally, a 700 HP. locomotive will be built for experimental work, and to attempt to solve as far as may be the various problems which are involved in Chicago. If my judgment is followed, there will be an experimental section of track in the form of a loop about 13 miles long with 18 miles of rail, and with every variety of single and double track construction, and simple and compound crossings and switches. On this I hope to see erected such varieties of overhead construction as may be found best to meet the various kinds of service, and where the problems of track jointly operated by steam and electricity can be developed in the most satisfactory manner.

On this track there will be not only this locomotive, but also one of equal rated capacity supplied by one of the larger manufacturing companies. The duty demanded of these machines will be severe. They will be required to haul a train of not less than 450 tons, at 30 miles an hour, up a grade of 26 ft. to a mile; to develop their full capacity at all speeds between 30 and 60 miles per hour, and if there is sufficient track room they will be driven at a speed of at least 75 and perhaps 100 miles per hour for short distances. The potentials used will be nearly double that at present obtaining in street railway practice.

A still larger problem, so far as power goes, although not in the variety of conditions which will have to be met, will be that recently taken for the operation of the belt line tunnel now being constructed in Baltimore to avoid the necessity of boat transfer at Locust Point. The duty of the motor will be to propel the train with engines coupled on, but not in operation, through a tunnel about 6,000 ft. long. The conditions require the motors, which will weigh about 80 tons and have a capacity of about 1,200 HP. to propel a 1,200 ton freight train up a grade of 42 ft. per mile at a speed of 15 miles per hour. Passenger trains of 450 tons' weight must be regularly started from rest twice in the tunnel on this grade, and in an emergency the freight train must start. The draw bar pull under regular duty, and when not starting, may be as high as 32,000 lbs.

Perhaps the traffic from New York to Philadelphia affords as good an example as any of what may be done on regular passenger service, provided the track is clear enough. For this I some three years ago, and again in the "Forum" of September, 1891, outlined an electric express service, with a method of supply through a rod carried above the car and a return circuit through the rails and earth. The current was to be supplied from one or more central stations, equipped with high-class triple expansion engines, driving multipolar dynamos directly coupled. What the electrical engineer, and the railroad man as well, need to know, is whether the electromotive force required on the line, and the number of stations necessary would be prohibitory.

No attempt was made at an excess of speed, but I confined myself to the average speed of a mile a minute for a distance of 90 miles, and considered a through service only. I assumed a total weight of copper of only about two-thirds that which exists on the long distance telephone line between New York and Boston. The trains were to be two-car units, leaving every ten minutes.

I found with these conditions the stations and potentials would be about as shown in the following table:

Station.	Miles apart.	Potential. 2 wire.	Potential. 3 wire.
1	—	3,600	1,800
2	45	1,800	900
3	30	1,300	600
4	22½	900	450

If the three-wire system is used, that is, the rails as a compensating conductor between two trolley rods, then with only two stations 42 miles apart, it is seen that the potential is less than 1,000 volts, and this we undoubtedly can handle.

I am not prepared to say that we may not use even a higher pressure, because I believe whatever is demanded in the interests of economy, all things being considered, will be used, but if we can reduce the potential to perfectly safe and reasonable limits by multiplying the number of stations, then those stations should be increased so long as the increase does not seriously affect the general expense of working. On a service of this character, where I have made the conditions distributed work and the dispatching of units at brief intervals, which conditions I repeat are absolutely necessary if we are to consider long distance transportation by electricity, such increase of stations as is advisable will not increase the cost of central station operation.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Establishment of Boundary by Declarations to Surveyor.

In an action to establish the boundary between two tracts of land, plaintiffs claimed title by inheritance from one S., and defendants, who derived title from P. and S., which fixed the boundary. From the testimony of a surveyor and others that S. pointed out to them the corners of the compromise line between himself and P., and from a recital in a deed given by S., the court was warranted in finding that the boundary fixed

in the agreement was the true one. (Scott vs. Means & Russell Iron Co., Ct. of Apps., Ky., 19, S. W. Rep., 189.)

Negligence of Contractor for City.

Where one who undertakes to build a retaining-wall for a city is to use his own implements, and employ, discharge, and have full control of the workmen; they are his servants and not the city's, notwithstanding that his remuneration is to be measured by the days' and hours' work of himself and his men, and he is liable for injury caused to a stranger by their negligence. A contractor building a retaining-wall used a derrick having one guy rope extending across the street. When this rope was tight it did not interefere with travel, but in lifting heavy stones it would sag so as to be within the reach of carriage tops. At first a prop was used to prevent the sagging, but in moving the derrick from one place to another the contractor failed to cause the prop to be put up. This was negligence for which he was personally liable to one injured thereby, and the fact that he was not present when the accident occurred was immaterial. (Geer vs. Darrow, Sup. Ct. Errors, Conn., 33 At. Rep., 1,087.)

PERSONALS.

Mr. A. G. Norton has been appointed Inspector of Brick Paving at Cleveland, O.

Mr. Louis Hills has been appointed Superintendent of Sewer Construction, at New Brighton, Conn.

Mr. John Bogart, M Am. Soc. C. E., has been appointed Chief Engineer of the Rapid Transit Commission of New York city.

Mr. E. W. Groves has been elected Chief Engineer of the Board of Public Works of Austin, Tex., vice Mr. Jos. P. Finzell, resigned.

Mr. G. A. Kimball, of Somerville, Mass., has been engaged as Consulting Engineer by the Sewer Commissioners, of Brockton, Mass.

Mr. Henry C. Merrick, City Engineer of Binghamton, N. Y., died July 9. He had had considerable experience in railway work, and was City Engineer of Binghamton for nearly 20 years.

Prof. Volney G. Barbour, of the University of Vermont, was married on July 12, at Burlington, Vt., to Miss Anna Wheeler, daughter of Mrs. Mary Hockley Wheeler, of that city.

Prof. T. S. C. Lowe, of Pasadena, Cal., President of the Mount Wilson Ry. Co., which proposes to build an electric railway to the summit of that mountain, has been appointed a member of the Board of Commissioners intrusted with the care and preservation of the Yosemite Valley.

Mr. C. M. Cook has resigned his position as Engineer of Maintenance of Way, of the Buffalo, Rochester & Pittsburg Ry., to attend entirely to his interests in the lumber and coal business in Buffalo, with the firm of Stengel & Cook. His department has been consolidated with that of the Chief Engineer, Mr. Hoyt, and the office will be moved to Rochester.

Messrs. Johnson & Flad, Civil and Mechanical Engineers, of St. Louis, Mo., have dissolved partnership. Prof. Johnson retires from the firm on account of his increasing duties at Washington University and the testing laboratory. Mr. Edward Flad will continue in business as civil and mechanical engineer, at the late office of the firm, 118 Laclede building.

Mr. F. W. Fratt, Chief Engineer of the Wisconsin Central Ry., has accepted the position of Engineer of Construction on the Missouri, Kansas & Texas Ry., with headquarters at St. Louis, Mo. Mr. Kendrick, Chief Engineer of the Northern Pacific R. R. and the Chicago & Northern Pacific R. R., will hereafter have charge also of the Wisconsin Central Engineering Department.

Mr. Wm. A Pike, Minneapolis, Minn., has resigned his position as head of the engineering department of the State University, and has opened an office as civil and mechanical consulting engineer, in the Guaranty Loan Building. He is prepared to design, inspect and test steam plants of all kinds, to design and superintend the construction of machinery, works in structural iron or steel, foundations, etc.

Mr. Bernhard Feind, M. Am. Soc. C. E., First Assistant Engineer, of Chicago, Ill., has resigned his position, owing to an effort being made to force him out for political reasons. He has been in the service of the city since October, 1885. He had direct control of the water supply and construction in that department, and has personally superintended nearly all the important water-works construction during the term of office of Mr. Clarke, City Engineer.

Mr. G. H. Turner has been appointed General Manager of the Midland Railway, England, vice Mr. Noble, who has retired on account of ill health. The Midland Railway is one of the principal trunk line systems of England, aggregating 1,300 miles in length, and is probably the most progressive railway in that country, owing to a fortunate succession of liberal minded men in the several departments, conspicuous among them having been the late Sir James Allport, to whom is largely due the beginning of the liberal and progressive policy of this company.

Mr. Edwin H. Wooton, of New York, agent of the Compagnie Generale des Asphaltes de France, died at Saratoga, N. Y., July 12. He was born in England in 1835 and came to New York at the age of 17. In 1874 he purchased from the assignees of a defunct asphalt company their plants and properties, and shortly after he was appointed sole agent in the United States and Canada for the Compagnie Generale des Asphaltes de France, and took the most active interest in the introduction of its asphalt for engineering and construction purposes. He was considered a high authority on the uses of rock asphalt. The business will be carried on under the management of his associate, Mr. T. Hugh Boorman.

NEW PUBLICATIONS.

REPORT OF THE CHIEF OF THE DIVISION OF FORESTRY FOR 1891.—B. E. Fernow. From the report of the Secretary of Agriculture for 1891. 8vo., pp. 39. Illustrated.

The report states that the past year has witnessed greater activity and interest in forestry matters than any previous year, due specially to the enactment of a law by Congress authorizing the President to set aside public timber lands for permanent forest reservations. The largest share of the expenditure of funds, as well as of the attention devoted to any particular work, has been bestowed upon the investigation into the character of the timber trees, which investigations have from time to time been referred to in our columns. In regard to rainfall experiments, the appropriations for which were included in those of this division, Mr. Fernow is careful to state that he had nothing to do with planning or carrying out the experiments. Statistics are given of exports and imports of wood products, and also some notes on water management, interesting particulars of forest planting experiments, and notes on forest reservations and their management. Several pages are devoted to a treatise on Southern timber pines, their distribution, quality, adaptation, nomenclature, etc., accompanied by maps and drawings.

KENTUCKY GEOLOGICAL SURVEY.—Report of progress from January, 1890, to January, 1892, by John R. Proctor, Director, Frankfort. Pamph., 8vo. pp. 26, with colored maps.

In this report is included a brief history of the survey from the date of its organization in 1854. Since 1880 the amount expended on the survey has been about $10,000 per annum; the cost for both topography and geology has been less than $5 per square mile. We give elsewhere some interesting information from the report concerning Bessemer steel manufacture in the South.

REPORT OF THE TENTH ANNUAL MEETING OF THE AMERICAN STREET RAILWAY ASSOCIATION.—Brooklyn, N. Y. 8vo., pp. 229.

This is the verbatim report of the meeting held at Pittsburg, Pa., Oct. 21 and 22, 1891. We published a report of the proceedings and abstracts of some of the principal papers. The volume contains the reports of the following special committees, with the discussions thereon: "A Perfect Electric Motor," H. A. Everett; "A Year's Progress of Cable Motive Power," J. C. Robinson; "Public and State Treatment of Corporations, No. 3," Hilton Scribner; "The Dependent (Overhead and Underground), System of Electric Motive Power," George W. Mansfield; "The Independent (Storage or Primary Battery) System of Electric Motive Power," Knight Neftel; "Standards in Electric Street Railway Practice," O. T. Crosby; "A Manual for the Classification of Expenditures of Electric Street Railways," H. I. Bettis. The business proceedings, excursions, etc., are also reported, and there are complete tables of the officers of the railways belonging to the association. It will be noted that by far the greater part of the meeting was devoted to the consideration of electric traction in its various phases, showing the interest taken in and the importance attached to this motive power by practical street railway men.

THE MICHIGAN ENGINEERS' ANNUAL, 1892.—Michigan Engineering Society. 8vo., pp. 214, illustrated.

This volume contains the proceedings of the society for 1892, including the following papers: "Building Stones of Michigan," W. H. Pettee; "Hydraulic Surveying," J. H. Forster; "Sewerage of Medina, N. Y.," O. C. Gillett; "Plats for the Surveyor's Office," E. Strong; "Expansion of an Amplitude," H. C. Pearsons; "Computation of Railway Earthwork and Haul," H. F. Bean; "Easement Curves," E. W. Muenscher; "Fundamental Principles of the Construction of Leveling Instruments," L. Beekman; "Notes in a Rolling Mill," E. H. Mumford; "The Arch, its Action," C. E. Greene; "Disposal of Sewage on land, with Particular Reference to Inland Villages and Isolated Buildings where Public Sewers are not Accessible," Geo. S. Pierson; "Ownership of Lake Beds," F. Hodgman; "Engineering for Cemeteries," O. C. Simonds.

WATER-WORKS REPORTS.—The following water-works reports have been received, the names being those of superintendents unless otherwise stated: Lawrence, Mass., A. H. Salisbury; Amsterdam, N. Y., A. H. DeGraff; Bridgeton, N. J., T. Woodruff; Camden, N. J., W. W. Mines, Chief Engineer; New Brunswick, N. J., C. H. Cramer.

SOCIETY PROCEEDINGS.

ENGINEERS' ASSOCIATION OF VIRGINIA.—A meeting was held at Roanoke, Va., July 5 and 6. Mr. Herman Crueger, of Roanoke, read a paper on the establishment of a national railway school for young men who intend to enter railway employment, either as civil or mechanical engineers, clerks, telegraph operators, etc.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The regular monthly meeting was held in Pittsburg, June 21, Mr. Alfred E. Hunt in the chair, Mr. R. N. Clark, Secretary. The paper of the evening was by Mr. W. Lucien Scaife, on "Some Data on Rail Joints." In 1885 a paper was read before the society by Mr. Max J. Becker on "Why Do Rail Joints Break?" This paper caused so much interest that a committee was appointed consisting of Messrs. Thomas Rodd, Max J. Becker, H. W. Borntraeger, the late W. R. Jones, C. L. Strobel, W. L. Scaife, Wm. Scherzer, James G. Dagron and Franz Engstrom. In order to obtain the benefit of the experience of railway engineers a circular was prepared, and sent to most of the railway companies in the United States and Canada. It contained a list of 25 questions, which were believed to cover the subject. In response to these and other circulars answers were received from engineers, general managers and superintendents of about 61,000 miles of railway. Many of them were accompanied by drawings of rails, splice-bars, roadbeds, nut-locks, etc., and furnished much valuable information outside of the questions contained in the circulars.

These were tabulated carefully by Mr. Engstrom, at the time they were received. Table No. 1 covers 35,600 miles of railway, and includes replies of those in charge, who are satisfied with the splicebars then in use. Table No. 2 refers to those who were in doubt, or dissatisfied with the then existing joints, and represents about 25,500 miles of road. Table No. 3 has been calculated by Mr. Engstrom, and shows for the various railways approximate values of the area, radius of gyration, moment of inertia, and center load of elastic limit, of the rails and splice bars, together with their relative values. An accompanying diagram shows the same values graphically.

An examination of the data cannot fail to show wide differences of opinion where they should not exist, and which it was the object of the Committee on Tests to settle. Considerable progress has been made since these communications were received, and the writer hopes that some of the railway engineers will add to this imperfect historical fragment the results of their more recent experience with rail joints. The committee by its request was relieved from further duty. The society adjourned to Sept. 20.

At the meeting of the Chemical Section, on June 28, Mr. R. B. Carnahan, Jr., read a paper on "Tin Plate Analysis." He described simple and rapid methods of determining tin, lead, iron and manganese in tin and tern plate; also spoke of the determination of tin in solder. The discussion turned upon tin alloys. The section adjourned to Sept., 27.

COMING TECHNICAL MEETINGS.

MONTANA SOCIETY OF CIVIL ENGINEERS.
July 16 Secy., F. D. Jones, Helena.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
July 21. Secy., C. F. Franson, 118 Adams St.
ENGINEERS' CLUB OF CINCINNATI.
July 21. Secy., J. F Wilson.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Aug. 5. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Aug. 5. Secy., O. von Geldern, 819 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Aug. 6. Secy., P. Valentine, At 221 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Aug. 6. Union Station, St. Paul.
WISCONSIN POLYTECHNIC SOCIETY.
Aug. 8. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinks.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Aug. 8. Secy., C. L. Annan.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Aug. 11. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Aug. 11. Secy., O. H. Landreth, Nashville, Tenn.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Aug. 18. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 3. 1122 Girard St., Secy., L. F. Rondinella.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York
WESTERN RAILWAY CLUB.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., R. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.
CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Macbeth.
ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy. J. H. K. Burgwin, Grand Rapids, Mich.

ENGINEERING NEWS

AND

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT. } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The index to Volume XXVII. of Engineering News, January to June, 1892, will appear with our next issue. Subscribers not receiving it with their paper for that date are requested to notify us promptly.

As we are advised that in some cases it may be inconvenient to send in graduating theses in competition for the three prizes which we have offered so early as July 20, the time for receiving them is extended to Aug. 1. We may add further that, as there is no particular reason for any stringency on that point, no thesis would be excluded even if received some days after that date.

It is reported that renewed efforts are to be made to make storage battery electric propulsion a success, this time by the Second Ave. street railway line of this city, and the Kings County Elevated Railway, of Brooklyn, N. Y. It is in some respects fortunate that there is such determined opposition to the introduction of the trolley system in New York. It makes at least one city where the traffic is very large a natural field for the experimental development of storage battery propulsion, since that is the only form which stands much present chance of being permitted. We have never been able to sympathize very strongly with this opposition to the trolley system. As between trolley motors and horses the preference lies decidedly with the trolley, in our judgment. But, on the other hand, if the storage battery system can be shown to be feasible at but a moderate increase of cost over the trolley system, it ought to be preferred and the trolley condemned and forbidden. As the trolley is probably the cheapest form of electric propulsion which can be devised, it is not to be expected that much effort will be made to develop any other system in cities where the trolley is permitted and already established. It is well, therefore, that there is one great city where it is not permitted.

The interesting annual address of President Mendes Cohen, of the Am. Soc. C. E., on the early history of the Baltimore & Ohio Railroad, which is concluded in this issue, adds some new facts to one of the most brilliant records in the history of American engineering, in addition to telling in a readable and entertaining way a story which will soon become only a tradition of the past, by the passing away of all those who had any personal connection with it. It is fortunate that under the new constitution of the society the president is left free to choose some subjects like this with which he is especially familiar for his annual address, instead of being required to choose as his subject "The Progress of Engineering During the Past Year," which usually means a dry and perfunctory address, compiled chiefly from the technical press of the previous year. If a society or a technical journal could have prepared for it each year an accurate and adequate summary of this kind, omitting nothing which was real progress, and naming nothing which was mere repetition without progress, we can conceive of nothing more interesting and valuable; but to prepare such an article would require something very like omniscience, and when a mere man attempts the task his article or address is almost sure to be disappointing, saying much which should not be said, and not saying much which should be said. Many technical journals have attempted to prepare such yearly summaries, but have found it impossible to do them well and have abandoned the attempt. The societies do well to follow their example.

In one respect only could we wish that Mr. Cohen's address had been different. In certain implied reflections upon the conduct of Mr. Jonathan Knight, the first Chief Engineer of the company, we cannot but feel that he has done a substantial injustice. So far as relates to Mr. Knight's alleged antagonism to his coadjutor and successor, Mr. Benj. H. Latrobe, we at least know this, that Mr. Latrobe himself cherished and freely expressed great and even affectionate admiration for Mr. Knight's character and abilities. He thus expressed himself to the present writer repeatedly in the confidence of personal correspondence. Mr. Latrobe's own character was so gentle and kindly that this fact in itself might not be decisive; but we may go further and say that in some of the circumstances which are advanced as evidence that Mr. Knight offended, we are unable to see any grounds for offense. Surely it cannot be admitted that because a man has been chief engineer of a road for many years he therefore owes a kind of permanent allegiance to it, and is honorably estopped from ever opposing its projects or accepting engagements which may be thought to conflict with its interests after he has left its service. We see no possible reason for any such rule of ethics. Its effect would be to greatly curtail the freedom of action of engineers. Passing the fact that the engineer's convictions of duty or public policy may lead him to disapprove of plans which his former company has formed—if certain interests oppose a line which an engineer's former company has decided on, and wish to engage his services to present the claims of another line in the best way possible, is there any reason whatever why he should not do so for a professional compensation? If so, we fail to see it. Both Mr. Knight and Mr. Latrobe deserve great honor for their work in creating the Baltimore & Ohio Railroad, as we understand it, and only honor. Each, doubtless, made mistakes; each had human weaknesses. But in the main they were coadjutors and not rivals, and American engineers should hold the memory of each in equal honor.

The overworking of railway employees in England has been for some years now a subject of agitation, and it is referred to from time to time in the reports made by the government inspectors upon railway accidents. In the investigation into the causes of these accidents, the time on duty of all the men concerned is inquired into and published in the report, making a record which the companies cannot go behind. The matter has recently been a subject of inquiry by a special parliamentary committee, in which much opposition was met with from the railway companies, attempts being made in some cases to intimidate men who had been called upon to give evidence. Some of these cases were so flagrant that the higher officials were summoned to appear before the house and were reprimanded. In the report upon a collision near Leicester, on the Midland Railway, in January, which was caused by freight cars being switched upon the main track in the face of an express train, the inspector says that the record of the hours worked by several of the men was not at all satisfactory, and he gives the time as follows:

	Day of Accident.	Previous Day.
Two switchmen.....	12 h. 22 m.	14 h. 0 m.
Freight conductor.....	9 15	14 40
Engineman and fireman of switch engine.....	12 52	13 15
Passenger conductor.....	13 45	14 35

The passenger train conductor had an interval of rest of two hours on the day of the accident, and three hours on the previous day, but it is justly pointed out that such short intervals cannot be considered as breaking the continuity of a man's turn of duty. The inspector, in concluding his report, says that men employed for such hours as these cannot be as fit for work at the end of their turn on duty as they should be, and that probably the long hours worked by the second switchman, who was held responsible for the accident, had the effect of making him less smart than he should have been.

Another accident, due to the overworking of a train conductor, occurred in December, 1891, when a freight train ran away on the Lancashire & Yorkshire Railway, on a 2½-mile grade of 2½%, owing to the failure of the vacuum brake on the engine. On such grades freight trains are required to stop at the summit, while the trainmen pin down the lever brakes on some of the cars. The conductor in this instance, however, did not apply a sufficient number of brakes, and the inspector says that this man had been on duty for 15½ hours, and was very probably smarting under a sense of disappointment at not having been relieved in accordance with his request. The engineman, too, had been refused a copy of the appendix to the time book, and was therefore not familiar with the special rule applicable to this grade. The inspector wisely recommends that every employee should be furnished with the appendix, as otherwise they cannot be expected to know all the special rules and regulations. It is not to be wondered at that accidents happen when switches and trains are in the hands of men too worn out to care very much how they do their work, and in fact it is to the credit of the faithfulness of the men that accidents due to this cause are so rare. This feature of English railway management is well known, and in view of the low wages which obtain there anyway, is little to the credit of the executive staff or higher officials.

The strength of the hull of a modern steamship has been well illustrated by the recent accidents to two of the Atlantic greyhounds. On June 22 the North German Lloyd steamship "Trave," while running at high speed, struck in a bank of fog the wooden sailing ship "Fred B. Taylor," and cut her completely in two. The wrecked vessel was 275 ft. long, 48 ft. beam and measured 1,800 tons. She was returning from Europe in ballast. The "Trave's" bow struck her about one-fourth her length from the stern and cut, not straight across, but somewhat diagonally through the hull. The ballast fell out and the bow and stern of the wooden ship floated apart. The "Trave" suffered astonishingly little damage, so little that, after picking up the crew of the wrecked vessel, she proceeded on her voyage. According to press reports a hole 4 ft. square was stove in one of her bow plates, other plates were cracked, both anchors were broken, and some of the forward rigging was swept away.

Ten days after the "Trave's" fortunate escape, the "City of Chicago," of the Inman Line, ran on the rocks on the Irish coast, a shore so rugged that the passengers had to be taken up a 200-ft. cliff by rope ladders. The vessel's bottom at the bow was, of course stove in by the shock, but only the forward compartment filled, and for several days hopes were entertained of getting her off. The final success of the attempts to save the "Elder," whose casting ashore a month or more ago our readers will doubtless remember, shows how much a modern steel vessel may endure in the way of running aground and still be able to float. We show on another page an engraving of the hull of the "Elder" when placed in dry dock, which makes this fact still more evident.

The correspondence of a journal like this sometimes throws an odd side light on the way in which public business is transacted. Nearly every city engineer finds himself more or less hampered in the execution of his work by a lack of accurate and complete office records. With many this lack is to a large extent their own fault, but with a few only is this wholly so. The responsibility often lies with municipal governments and with citizens who look upon city engineers as men who measure distances and establish grades at the moment when they are necessary and have no need of records. Frequently also the city engineer is engaged by the day and has

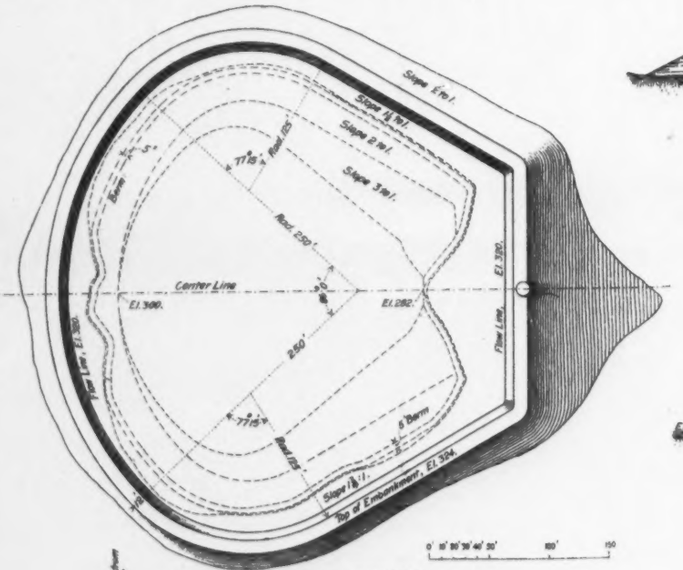


Fig. 2. PLAN OF RESERVOIR.

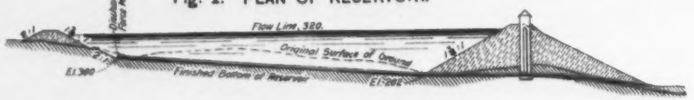


Fig. 3. SECTION ON CENTER LINE.

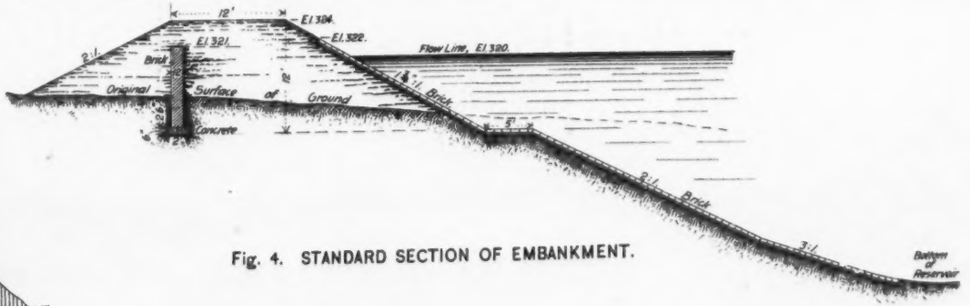


Fig. 4. STANDARD SECTION OF EMBANKMENT.

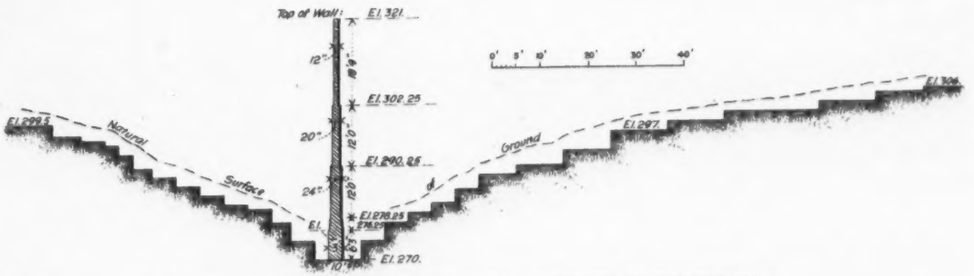
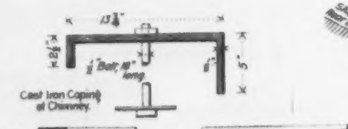


Fig. 5. SECTION OF HEART WALL SHOWING STEPPING OF FOUNDATIONS.



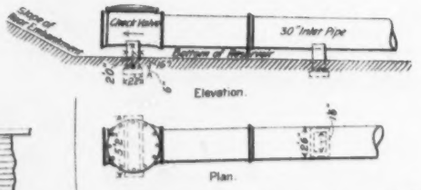
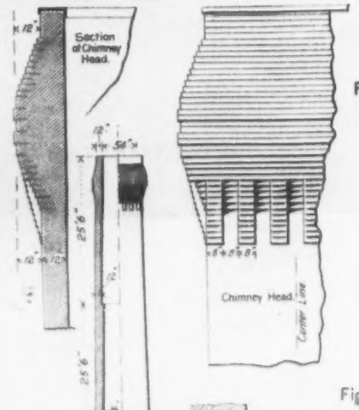
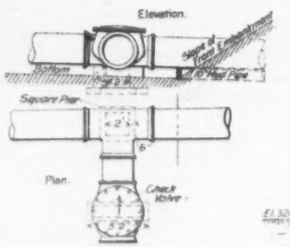
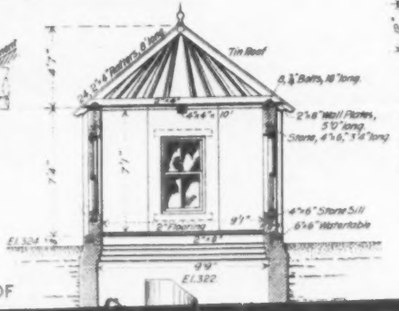


Fig. 6. TERMINATION OF FORCE MAIN IN RESERVOIR.







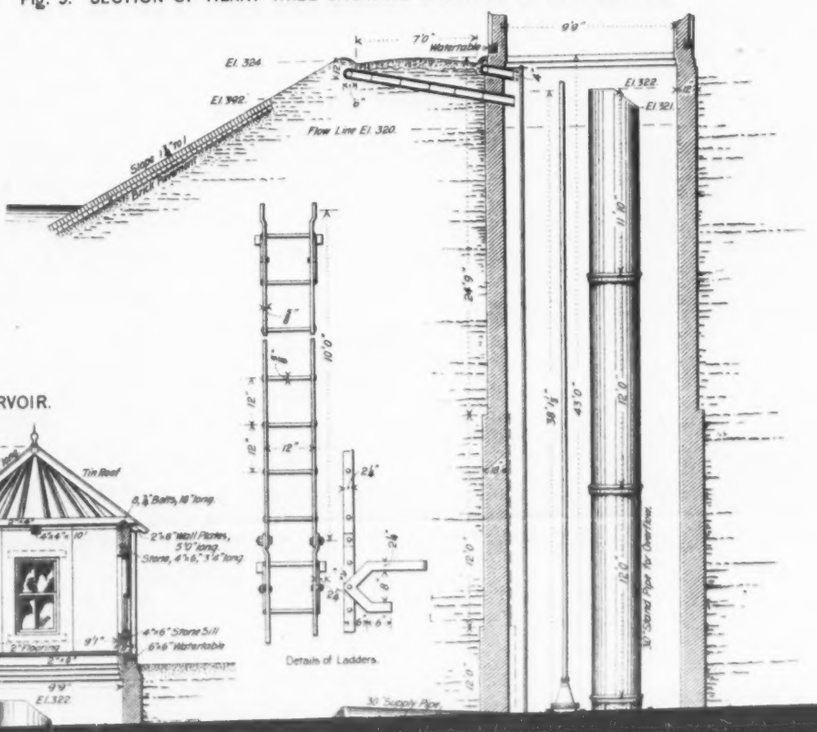


Fig. 7. CHECK VALVE AND END OF

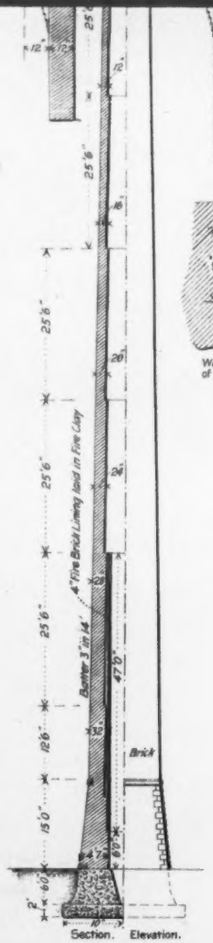


Fig.1. DETAILS OF CHIMNEY.

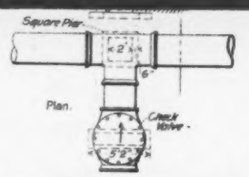


Fig. 7. CHECK VALVE AND END OF MUD PIPE NEAR GATE HOUSE.

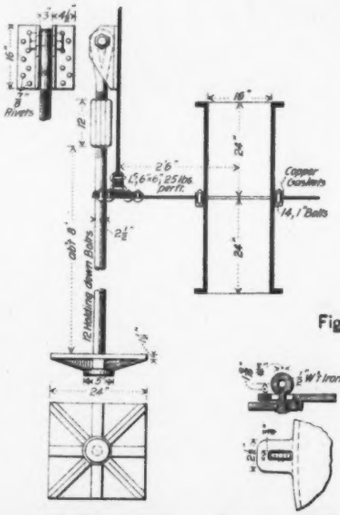


Fig. 12. "HOLDING DOWN" OR ANCHOR BOLTS.

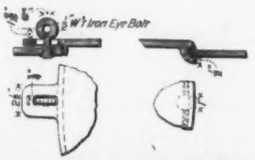
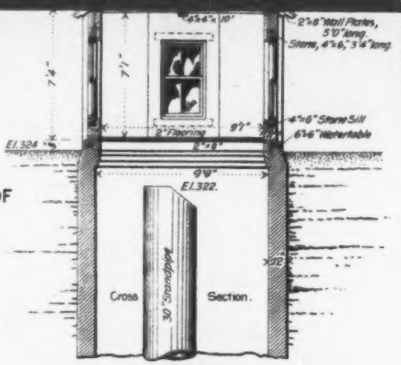


Fig. 11. DEVICE FOR LOCKING CAST IRON MANHOLE COVER FOR VALVE CHAMBER.



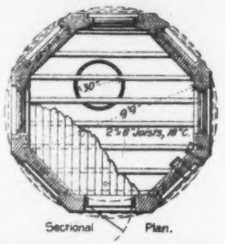
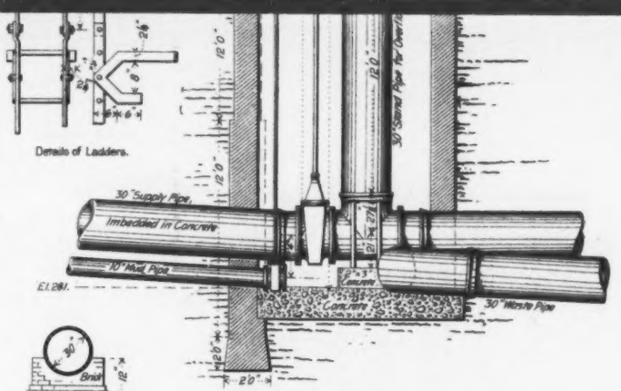


Fig. 9. DETAILS OF HOUSE OVER GATE CHAMBER.



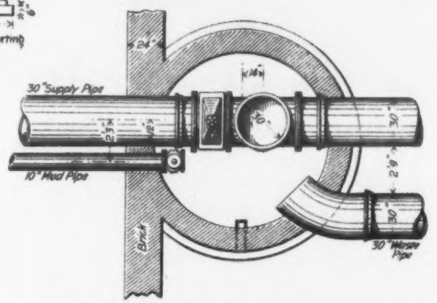
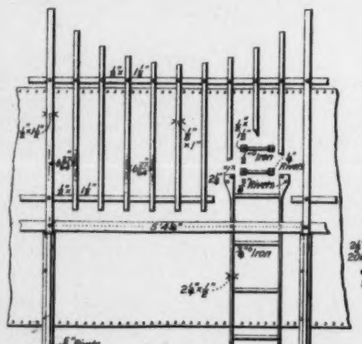
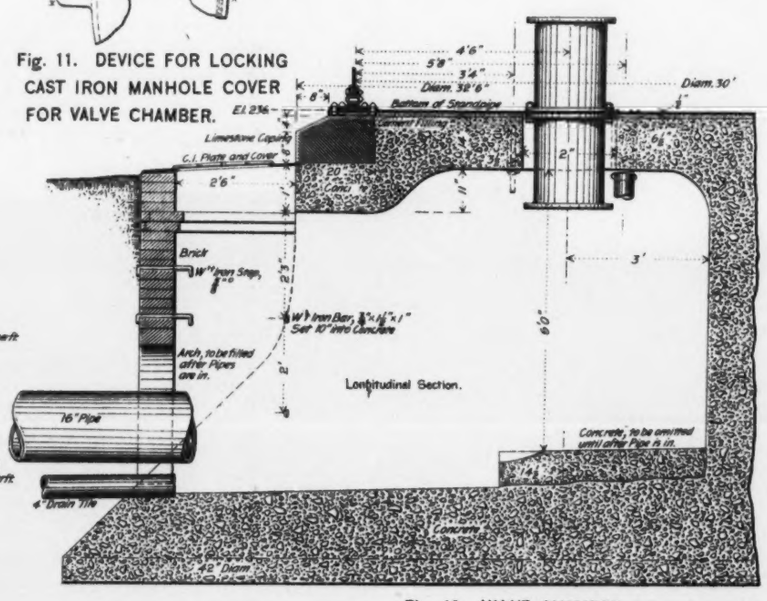


Fig. 8. DETAILS OF GATE CHAMBER.





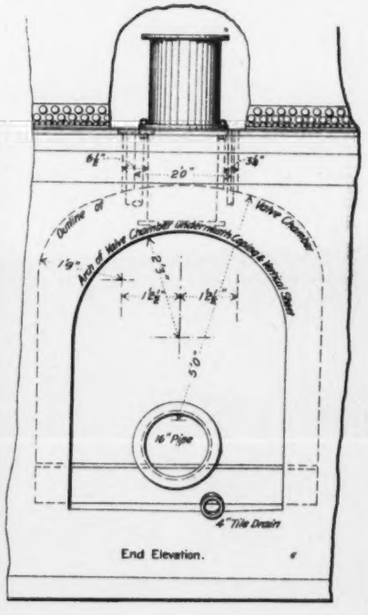


Fig. 10. VALVE CHAMBER OF STAND-PIPE.

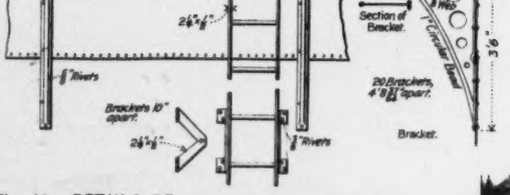
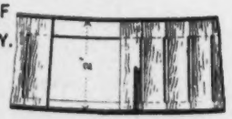
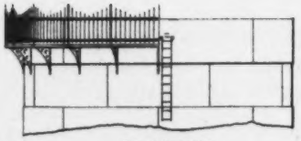


Fig. 13. DETAILS OF STAND-PIPE BALCONY.


Platform.


Top of Standpipe.

THE WATER-WORKS OF PEORIA, ILL.

Chester B. Davis, Designing and Consulting Engineer.

E. H. Burlingame, Constructing Engineer.

Moffett, Hodgkins & Clarke, Contractors.

CHAS. HART & SONS, LITH., 50 VESEY ST., N. Y.

no trained assistants. There is no regularity in his service, and such notes as he keeps he considers his private property, as in the case of any other work.

A letter received some time ago from a city engineer in response to a request for information regarding the sewerage system of a city with more than 30,000 inhabitants, illustrates the above points so well that it is given in full below, omitting locality, date and signature. The letter is its own best comment:

I am unable at present to fill up the blank you sent me. I have been in this office only one year and my predecessor had been here 26 years. When he left he claimed the few records he had kept as his own, and he left me very little more than the bare walls of the office. He has a book containing the record of sewers now in use, which he offered to sell to the city, but the Council refused to buy, as they believed it should belong to the city by right. I think they will soon decide that the cheapest way to get it will be to buy it, and I will then let you know what it contains. As there were no records or notes of any kind in the office when I took charge (except a record of street grades), I have not been able to make much headway during the year. I hope to get affairs in shape soon so that the report from this office can take its place with any other well conducted office.

PROGRESS ON NEW YORK'S RAPID TRANSIT SCHEME.

New York city's proposed rapid transit railway system has now passed safely another stage in its progress. On July 7 the general term of the Supreme Court handed down a decision confirming the report of the three commissioners appointed to review the scheme as submitted by the Rapid Transit Commission and overruling the objections which have been filed by property owners. Concerning the question of ventilation the judges say:

We are of the opinion, upon an examination of the facts, that the success of the enterprise is not a question of engineering, but a matter of finance; the engineering problems can be overcome without any difficulty, providing the money is behind the engineer; and under the plan of construction adopted by the Rapid Transit Commissioners, most, if not all of the objections which have been raised to the fact of the railroad being constructed in a tunnel, will be obviated. In the first place, there will be no combustion in the tunnel in the production of motive power, which is a main cause of the vitiation of the atmosphere in the tunnel. In the next place, the cars will not be lighted either by gas or oil, and hence this source of pollution will be avoided; and furthermore, in consequence of the rapid movement of the trains, it will be impossible for the air in the tunnel to stagnate, which is another prolific source of pollution; and there seems to be no difficulty whatever in successfully coping with the problem of ventilation.

We agree with the judges in this opinion. The horribly polluted atmosphere of the Metropolitan Railway lines in London and the Grand Central approach here has created a strong and natural prejudice against transit in long tunnels, but if combustion in the tunnel be dispensed with most of this difficulty disappears, if not all.

The rapid transit scheme has now been passed upon by three legally constituted tribunals, each of which has expressed its approval. For a time at least the enterprise has no more gauntlets to run in the shape of courts or commissions. The next step is the preparing of detailed plans and specifications for the construction of the road, including, according to the wording of the law:

All devices and appurtenances deemed by the Commission necessary to secure the greatest efficiency, public convenience and safety, including plans and specifications for suitable supports, turnouts, switches, sidings, connections, landing places, buildings, platforms, stairways, elevators, telegraph and signal devices and other suitable appliances incidental and requisite to what the said board may approve as the best and most efficient system of rapid transit in view of the public needs and requirements, and the said board may in its discretion include in said plans provisions for subways or tunnels for sewer, gas or water pipes, electric wires and other conductors proper to be placed under ground whenever necessary so to do in order to permit of proper construction of any railway herein provided for in accordance with the plans and specifications of the said commission.

As soon as the plans and specifications are complete the law requires the Commission to sell the franchise for the construction and operation of the road at public auction, the sale being advertised for at least six weeks. The Commission is to prescribe all such terms and conditions of sale as it may deem to be for the interest of the public and of the city in which the railway is to be constructed. The law specifies, however, that the terms of sale shall provide for the construction of the railways under the supervision of the Commission and subject to the approval of its engineers, that the successful bidder shall deposit sufficient cash or securities to guarantee its good faith, that dates shall be specified for the commencement and the completion of the road, and that the purchaser shall organize a corporation to exercise the franchise granted. The capital, number of shares, limit of bonded indebtedness, and maximum rates of fare and freight are also to be stated in the terms of sale. The Commission may accept whatever proposal they deem most advantageous for the city. Finally the provision is made that the sale of the franchise shall be for a definite term of years. The resale, however, at the expiration of the term, which is also provided for, is not to affect the rights of the creditors or bondholders of the first corporation.

In a few weeks more, therefore, we ought to know whether the scheme is sufficiently promising to attract capital or not. We see little reason to fear that it will not. A rapid transit line up Broadway with an eastern branch to the Grand Central Station is a financial tidbit at almost any cost, in our judgment. Should there be an apparent lack of bids at the first sale it will be more likely that bidders are holding off for better terms than that none intend to bid. Of course the enterprise is too vast to permit of many bidders, under terms of sale which will certainly be so drawn as to require prior evidence of good faith from bidders; but the prize is so great a one that it will be rather dangerous business to "monkey" with the bidding very much, and we shall rather expect to see the franchise knocked down to some one at the first auction.

In the routes as laid out there is one serious defect, as we have before noted. As a permanent arrangement it is absurd to suppose that a four-track trunk up Broadway can receive and transmit the through traffic of (1) a four-track east side and four-track west side line in addition to (3) its own local traffic. But the configuration of the city is such that it will be at any time easy to build an independent four-track line from Union Square down, so as wholly to separate the east side and west side traffic, without sensible disadvantage from the delay. The two lines naturally come very near together at Union Square anyway, and they would need some cross-connection with each other at that point even if both lines were to be built at once.

Under these circumstances it was a wise and shrewd move not to load the project with the east side extension from the beginning, but rather to center both branches on the Broadway trunk, so as to insure to that costly bit of line all the traffic it could carry from the beginning, and thus strengthen the chance that the franchise would be sold, and on favorable terms to the city. This apparent fault in the plans, which has been much animadverted upon, has been to us one of the strongest evidences that the Commission "meant business," and were trying to draft a plan which would be sure to find favor with capitalists. By so doing the immediate investment of capital was reduced by many millions, with no measurable loss to any one so long as the capacity of the Broadway line is not exceeded. So soon as it is exceeded the east side extension can be soon built, and more cheaply than if built at once.

The Commission, doubtless, foresaw also the trouble as to the Madison Ave. part of their route, which can never have been seriously proposed by them, and foresaw that until the question was settled of how the east side line was to reach the Harlem River there was no necessity for any east side trunk below Union Square. As we have already stated, it seems to us that the proper solution of this latter problem is to convert the Grand Central tunnel approach into an open cut and to put four more tracks above the four now in the tunnel. If that solution be not accepted some other must be found ere long, and when it is found, and not till then, it will be time enough to borrow trouble over the lack of an east side line below 14th St.

THE HOMESTEAD TROUBLES.

It is easier to understand the true significance of the pending unfortunate dispute at Homestead, if we consider certain features of this class of disputes in the abstract, quite apart from the circumstances of this particular case. The conditions of modern life have changed so rapidly and greatly that many people have failed to grasp some of the reasons which make these labor troubles so exceedingly difficult to deal with, though they are not so hard to see if one considers all the facts dispassionately.

In every dispute between master and man on a question of wages or condition of service there are three main possibilities: 1, that the claim of the master is reasonable and just, and ought to be acceded to; 2, that the claim of the men is reasonable and just and ought to be acceded to; 3, that the claim of neither is quite just, but that the truth lies between them. This last case we will disregard as in effect a mere combination of 1 and 2, and consider only the first two.

When the claim of the master is just, he has under the law every advantage in maintaining that claim without going a single step beyond his legal or moral rights. He may even go beyond his moral right, by being arbitrary, offensive and dictatorial in his way of announcing his position, and still he has under the law every advantage in maintaining that position without exposing himself to censure or to legal interference. He has only to announce his position, call upon his men to accept it or leave, and call upon the law to put him in possession of his property if the men attempt to resist. As the "Evening Post" put it, in speaking of this very case:

All that the employers can possibly ask for or desire is law and order, because that means that new workmen will appear after some interval and take the places of the old hands, and that in any case the old hands will be driven back by hunger some time. Law and order is the very thing that the men cannot afford. They had better surrender in the beginning than take their chances under any such regime.

When the claim of the men is just, and that of the master is unjust, their chances for enforcing their claim are very different. The master has still only to announce his position, just or unjust, call upon the men to accept it or leave, and call upon the law to put him in possession of his property if the men attempt to resist. It still remains true that "all the employer can possibly ask for or desire is law and order, because," etc., etc., as just quoted. Thus, although the end and aim of the law is always to work justice, and never injustice, in this particular case it works in favor of the master, just or unjust, and against the men.

This is in great degree, if not wholly, inevitable, because the right of the master to control the management of his own property must be recognized and maintained. Nevertheless it is an element of the situation which should not be forgotten. It may be said and many think that the master enjoys this advantage because he has such a natural right to the absolute control of his property that the law has no right to interfere; but this is not the case. The law always interferes to prevent injustice where it is possible to do so effectively. It is only by the aid and protection of the law that any man is enabled to accumulate and hold property at all, beyond the needs of a hand-to-mouth existence, and the law can and does step in in many ways, and say that what has been accumulated only by the aid and protection of the public shall be used only in ways that do not injure the public. It is the immense difficulty of framing any law which shall meet the case without doing more harm than good, and that alone, which prevents the passage of laws to protect the employed from unjust demands of employers.

These facts should make us charitable toward the unlawful acts of striking or locked-out workmen, even when they go to the length of doing great injustice to an employer who is doing his best to satisfy their demands and have something left for himself. By an unfortunate necessity of the law the men have no other than unlawful modes for effectively asserting their demands even when just, if they are disputed, whereas the employer has lawful means for asserting his demands even if unjust.

In other words, the employer is under the law the sole arbiter as to what wages he will pay his employees, whether he be just or unjust in intent, and whether he means to be fair or unfair. Under old conditions of simple arts and many small employers,

this did not much matter. If one blacksmith discharged a man there were half a dozen others in the next block in the next town from whom he might seek employment, and generally find it. Under modern conditions it often matters very gravely. In the first place, it is a wholesale instead of a retail matter. Discharging 4,000 men at once is a much more serious matter to each of those men than if he were discharged alone. They have probably bought homes in the town, and to leave them all at once means the loss of their savings, as well as of their friendships and home associations. It is said that about two-thirds of the men now locked out at Homestead own their own homes. Naturally they do not take very kindly to suggestions that if they are not satisfied all they have to do is to leave the place. If it is true that their only alternative is to do so or accept less than a fair wage, as they claim, they are in a hard and unfair position. Morally, they are entitled to a hearing on that issue of fact before an impartial and disinterested judge, and not merely before their deeply interested employers, before they are compelled to do so. Practically it seems impossible to provide for this without denying to the owners the right to manage their own property, which of course must be maintained. In the second place, the specialization and concentration into a few hands of modern industries has gone so far that in case the result of any strike goes against the men it may be extremely hard for them to find employment elsewhere. Even in the great steel industry there are only half a dozen other plants to which the Homestead men could go if they fail in their efforts there with any hope of obtaining new employment in the same line, and to whichever one of these they went they would be very likely to be denied employment merely because they came from Homestead. Therefore, while the men can and do inflict needless and great losses upon the employer by sudden striking, yet after all the employer has a tremendous power over the men, and where is the guarantee under the law that either side will not use their power oppressively? It does not exist, and we have already said that we do not as yet see exactly how it can exist, as against the employer, and not interfere with the efficiency of manufacturing establishments and the inducements for capital to go with them. The most feasible way seems to be the enactment of some law compelling both master and man to submit such disputes to arbitration, under carefully guarded provisions, and abide by the results. And yet, as it would be impossible to compel the men to conform to the spirit of such a decision, if not to the letter also, where would be the fairness of compelling the master to do so? He would stand in to have to pay higher wages than he thought he could afford if he lost, and have a discontented, surly set of hands who would render him as little service as they could, or refuse outright to render him any service at all, if he won.

The subject is beset with difficulties, but let us not increase them by judging the men over-hard when they resort to lawless measures, in default of any legal method for maintaining their side as they see it. Lawlessness must be put down, by whomsoever attempted, but we cannot but feel that it rests upon the state and not upon private individuals to put it down, and therefore we cannot but feel that the ignominious defeat of the Pinkertons will be anything but a public misfortune if it puts a stop to that most dangerous and obnoxious practice, hiring organized private troops to act under the command of the very individuals whose passions are most inflamed, to resist public violence. How and when to fire upon mobs is one of the most solemn and serious duties of high public officials. That it should become a custom for parties in interest to hire men through whom to do their own fighting for their rights, on the ground that the public authorities were too slow for them would be in a sense a more threatening sign than even the acts of mobs, because the mob at least fights its own battles, and has the steadying influence of personal risk, but the hirer of Pinkertons has no such restraint upon his angry passions. He might well say to his Pinkertons as the Irish absentee landlord said to his steward, who advised some concessions in rents because the tenants threatened violence: "Tell my tenants that if they think to terrify me by threatening to kill you they have mistaken their man!"

Calling these Pinkerton men "detectives" is an absurd misuse of terms. They are rented out in bulk to the employers at (usually) $5 per day and subsistence. They are enlisted at $2 to $3 per day while the job lasts, which is usually for a few days only. Men who will incur such risks for such a price in quarrels not their own must necessarily be for the most part of a very inferior class. Of course their errand at Homestead was a perfectly lawful one, and no one had a legal right to oppose them. Theoretically a man has as much right to hire 300 men as to hire one man to help defend his property, as much right to fight for an entrance to it as to resist the entrance of others, as much right to turn over the attack or the defense solely to his hired men as when he fights with them himself; as much right to fight for the possession of his property against men whom he has injured as against men who have injured him. But practically it makes a great difference. Practically the Pinkertons were making an offensive movement under private command against a mob numbering thousands, which it was the duty of the state to make if it was made at all.

LETTERS TO THE EDITOR.

WEB PLATE SPLICES.

Sir: In your number of June 30, there is a method suggested for transferring the moment of the web plate at a splice. If the web is strengthened solely by cover plates, the method might be a good one, for that style of work, but it could hardly be called good practice, if practice at all. It is customary to splice webs by means of splice plates, the rivets of which are calculated to carry the moment of the web at that point.

Yours truly, C.

CEMENT TESTING SIEVES.—CORRECTION.

Sir: In my article in your last issue, "Variations in Cement Testing Sieves," you have erroneously given me the title of U. S. Asst. Engr. Laborers as well as engineers have their mail come in care of this office. You will oblige me by giving space to this correction. Very respectfully,

L. C. Sabin.

U. S. Engr. Office, Sault Ste Marie, Mich., July 3, 1892.

(The title was wholly one of our own conferring, not of the writer's claiming.—Ed.)

FAST TUNNEL DRIVING.

Sir: We have the following letter and would thank you to publish the facts. They are absolutely reliable:

"At York Farm Tunnel, near Pottsville, on the Lehigh Valley R. R., we drove in the month of June last, in a single heading 333 ft. of tunnel, finished complete, including ditch as measured by the engineer this morning. We used Ingersoll-Sergeant drills exclusively, miner's safety lamps, and we did no Sunday work.

Joseph Dolan, Contractor."

Pottsville, Pa., July 1, 1892.

The foregoing is a clean and remarkable record, as it occurs in hard rock, and in the general course of work, that is, the drive was not a special one, for which any special preparation had been made. Yours truly,

Ingersoll-Sergeant Drill Co.

New York, July 6, 1892.

THE IRON WHARF AT FORT MONROE.

Sir: In the abstract of my paper on the Iron Wharf at Fort Monroe, Va., published in your issue of June 30, 1892, there are a few typographical errors. The first is on p. 662, 1st column, line 35, where the cast iron is described as "without combined carbon." This should have read, of course, "without uncombined carbon." This error occurred in the advance copy of the paper, the proof of which I did not see before its issue, and was only copied by the News. In the same column, lines 15 and 16 from bottom, the sentence commencing "The middle," etc., should read "The middle section is 8 ins. in interior diameter and 1 in. in thickness, and has," etc. In the second column, 2 lines from bottom, for "plates" read "piles." Very respectfully, John B. Duncklee.

CIRCULAR CURB CORNERS.

Sir: In relation to the radius of curb corners, referred to in your issue of last week, the ordinary radius in use in this city is 5 ft. 8¾ ins., which makes the length at a square corner just 9 ft. We find this a convenient radius, as it enables the exact length to be readily ascertained when the angle between the curb of the intersecting streets is known. For example, if the angle between the curb lines is 60° 30′ the length of curb needed is at once seen to be 11.95 ft. For each degree that the angle is less than 90°, 0.1 ft. is added to the usual 9 ft.

Where the carriageway is unusually narrow and the traffic is considerable, it is often best to make the radius 9 or 10 ft.; but this can only be done where one of the sidewalks is of considerable width, that is to say, where a narrow carriageway runs into a wide one. Poles at street corners, and less frequently receiving basins, often make it difficult to enlarge the radius when old streets are re-curbed. Very truly yours,

Horace Andrews,

Albany, N. Y., July 11, 1892. City Engineer.

SIZE OF EXHAUST NOZZLE ON SIMPLE AND ON COMPOUND LOCOMOTIVES.

Sir: I notice in your paper of June 30 that in the discussion of compound locomotives at the Master Mechanics' Convention "H. Smart," of the M. C. R. R. is put on record as saying that a larger exhaust nozzle is used on the simple than on the compound engines. My statement in regard to this, on the occasion referred to was in substance, "that we could use a larger nozzle on the compound than we could on the simple engines; that where we used a nozzle of 4½ ins. or 4¾ ins. diameter on the simple engine, we would have no difficulty in using 5⅛ to 5¼ ins. on the compound engine with good results."

Yours very truly, C. E. Smart,
General Master Mechanic.

Jackson, Mich., July 6, 1892.

TIME ALLOWANCE FOR STEAM YACHT RACING.

Sir: Can you tell me through your paper of any equitable rules for time allowance in a steam yacht race, based on the length of load water line?

Yours truly, R. E. Hunter.

Sorel, P. Q., June 15, 1892.

(From its very nature no time allowance can be strictly equitable. In order to obtain the highest attainable authority on this point, however, we addressed a note of inquiry to the famous Rhode Island firm of yacht builders, and have received from Mr. Lewis Herreshoff the following response.—Ed.)

Sir: Your letter inquiring of tables of allowance between steam yachts came this morning, since which, I have been thinking over the subject. In the absence of my brother, N. G. Herreshoff, I cannot answer decidedly if there be such rules or not, but I think none exist.

No tables of allowance could be based on L. W. L length alone. The length should be a factor among several, area of section, piston area, steam pressure, and so on. It would be a very complex business to frame such a rule, and no satisfaction can ever be had out of steam yacht racing, even if tables of allowance were made. Pray lend your influence to discourage steam yacht racing; it amounts to nothing and cannot teach anything.

I have a slight recollection that Chief Engineer B. F. Isherwood, U. S. N., once devised some rules for allowance among steam vessels. It might be worth your while to address him on the subject; it might at least bring out some suggestions from him, and as he is to-day one of the best informed engineers in the world, his words would be of value. I am truly yours,

Lewis Herreshoff.

Bristol, July 9, 1892.

THE EFFECT OF HEAT ON CEMENT MORTAR.

Sir: In the edition of your valuable paper of June 23, I notice an inquiry as to the effect of heat on Portland cement mortar, and a request on your part that your readers may report as to the use of cement under the conditions referred to. In reply I would state, that in the construction of kilns and chimney-stacks, our experience agrees very much with that stated by you, "that cement mortar will stand a moderate degree of heat," but we have known of cases where in the case of fire in mines, cement has been used to stop the spread of the flames. Of experience reported in the technical papers, that which comes nearest to answering the inquiry of your correspondent is given in the "Proceedings of the German Cement Manufacturers' Association" of 1891, where, in the course of a debate, Herr Siber stated some experience of his own, in reference to using cement under the conditions mentioned. He stated that in his cement factory "it has been the custom for years to close the manholes or other covers of the boilers with cement, without any further packing. A cement mortar of somewhat thicker consistency than treacle is made and put where packing was formerly used to close the covers. I find no packing gives such satisfaction as this."

Another experience of not an identical character, though somewhat similar, is shown in a letter of J. M. Willcox & Co., to the American Cement Co., dated April 7, 1887, referring to the use of cement in paper mills, which is as follows:

"We built our drains and acid tanks of brick laid with this same cement, and, as you know, the walls of the drains are subjected to very heavy pressure, yet are still firm. The acid tank we laid with brick,

one row on edge, and then gave it a slight dashing of cement, pure. We had occasion to enlarge this tank a few days ago, but in order to get the brick out, we had to break them, as the cement would not give, seeming to have become part of the brick. The brick in that case had been in position a little over three years, and the tank was always filled with solution of chloride of lime.

From these three illustrations, it can be seen that the uses of Portland cement are manifold, though the writer has grave doubts as to its use under the peculiarly trying circumstances referred to by Mr. Pierce in his letter to you. Yours truly,

R. W. Lesley.

Philadelphia, June 28, 1892.

CEMENT JOINTS FOR WATER PIPE.

Sir: While at Pawtucket, in charge of the construction of the Dunnell Mfg. Co.'s new plant, for Lockwood, Greene & Co., mill architects and engineers, I learned of the existence and present use of the water pipe with cement joints, mentioned in your issue of the 23d inst. This pipe was laid by the Pawtucket Steam & Gas Pipe Co., and Mr. David Fales, of that company, can doubtless give a full history of its behavior.

Very respectfully, W. P. Snow.

Auburndale, Mass., June 25, 1892.

(In response to inquiries as to the substance of the above letter we have received the following, which sufficiently explains itself.—Ed.)

Sir: Your letter of 29th ult., addressed to our Mr. Fales, has been handed to me for answer, and after carefully looking into the same, I beg to advise you as follows:

During the years 1869 and 1870, we put in for the Central Falls Fire Corporation, a fire service, consisting of 4-in. and 6-in. pipe and pump. The joints of this pipe were made as follows: First, a layer of marline, or tarred rope, was well calked into the joint; then a layer of Roman cement, followed by another layer of marline, and this, after having been well calked, was pointed up and finished with Roman cement.

As to the feasibility of using cement for this work, you must judge for yourself by the result. During the time when used for fire purposes, the gage on service pump frequently showed up to 150 lbs. pressure, and under this heavy strain the joints stood admirably, and in our recollection, we never had a leaky joint. Some 13 years ago this system of fire protection was discontinued, and a new water service was obtained from the Pawtucket Water-Works, and it became a serious question as to whether new pipes should be laid, using lead joints, or connection made with the old fire service. But this was finally settled by replacing some, and leaving a part of this old system, which is still in daily use. The water pressure at present ranges from 90 to 100 lbs.

Two years ago we had a leak in this old pipe, which we at first were inclined to attribute to the blowing out of the cement joints, but upon uncovering the pipe for about 50 ft., we found every joint perfectly sound, and the leak caused by a split through the center of a length of pipe. This pipe, having been in daily service for over 20 years, we think speaks for itself, and we can only add that the cost of maintenance and repairs has been comparatively nothing. We would add that the bells in these old pipes were 4 in. deep, and we would not advise using a less depth than this, on account of getting in a sufficient body of cement. We trust that this may be of service to you or your correspondent, and should be pleased at any time to give you any further information on the subject which we may have. Yours very truly,

Pawtucket Steam & Gas Pipe Co.,
J. E. Andrew, Secy.

Pawtucket, R. I., July 1, 1892.

NOTES ON ITALIAN RAILWAY PRACTICE.

Sir: As I have recently made an exploration trip of some length, looking up Italian railways and Italian railway practice, the following notes in regard to some of its peculiar features may have interest for your readers.

The locomotive engineers on the chief Italian roads are divided into seven classes, each receiving a certain fixed sum, and whatever they can make by economy in coal, oil, picking up lost time, etc., as an extra. On the Mediterranean system there are 764 enginemen of all classes, graded according to the number of years they have been in service. There are

26	of the	first class,	receiving	$480 per year.
83	"	second "	"	420 "
79	"	third "	"	390 "
124	"	fourth "	"	360 "
87	"	fifth "	"	330 "
102	"	sixth "	"	300 "
263	"	seventh"	"	270 "

in each case taking the lire or franc as 5 to the dollar. Thus it appears that the upmost which a locomotive engineer is assured of is $480; that is his substance. For the shadow, he has to look for uncertain and varying economies, and this shadow has been artificially decreased yearly, as it tended to grow more important. As the men became skillful in economizing, the company have cut down the reserve of supplies allotted to them. The administration has said, in effect: You have shown that you can do so much with so much coal, so we propose in future to allow only that much; if you realize any further economy on that, you will get the ordinary percentage. This is something like putting men on piece work to find out what they can do, and then expecting them to do the same amount of work on time. The per cent. allowance for saving, is very small, amounting to $1.40 per ton of coal, and about 1½ ct. per quart of oil. There is also a peculiar allowance for making up time, by reducing the time between stations, without exceeding the maximum speed of engines. This is usually from 3 to 5 centissimi (0.6 to 1.0 ct.) for each minute saved, varying according to the type of the locomotive, and the number of miles run. For time made up when the train is behind time, 3 cts. per minute is paid for passengers, and 2 cts. for freight trains, which amounts are reduced to 2 and 1 ct. respectively, for distances of over 93 miles. Drivers are paid over time in the following per cent. in excess of their earnings. If absent with their engines, for over 15 and up to 19 hours, 50% extra.

18	"	24	"	100% "
24	"	36	"	150% "
36	"	48	"	200% "

Thus there are, of course, a number of small ways which the driver has of increasing his small stipend.

The Italian railway reports are nearly all figures, with little or no text. The private railway reports are lithographed copies of handwriting. From either, it is extremely difficult to determine any accurate information, as the lithographs are in a kind of hideous German script.

The Italian third class railway carriages are exceedingly uncomfortable. I send you a lithograph of one of the latest styles. There are, perhaps, no worse cattle cars in Europe. They are mere boxes, with no side windows, and only small apertures in the doors. There is no roof ventilation, so that the interior gets heated like an oven under the sun's rays. The illustration I send is of a slightly improved type. It shows five separate compartments, each 5 ft. wide inside, thus allowing very little space for the knees. There is a side gallery connecting the two end compartments, so that all communicate with a central water closet, which is quite a new feature for third class cars. The width of the car is about 9 ft. 3 ins. The running gear is of the usual European type, far too weak for service in American trains.

For fuel, briquettes are used on Italian lines, as on most other continental roads. They give off a frightful amount of grit, as the coal is not damped. The total mileage of the Mediterranean railway system is some 2,670 miles of single and double track. The head offices are in Milan, housed in a vast edifice already, but with a still larger one in course of construction. The paid up capital is $52,000,000. The other great company, the Adriatic, has its headquarters in Florence. It is this latter and less important company which has introduced electric lighting in its coaches. The cars are supplied by means of storage batteries, from the principal station at Milan.

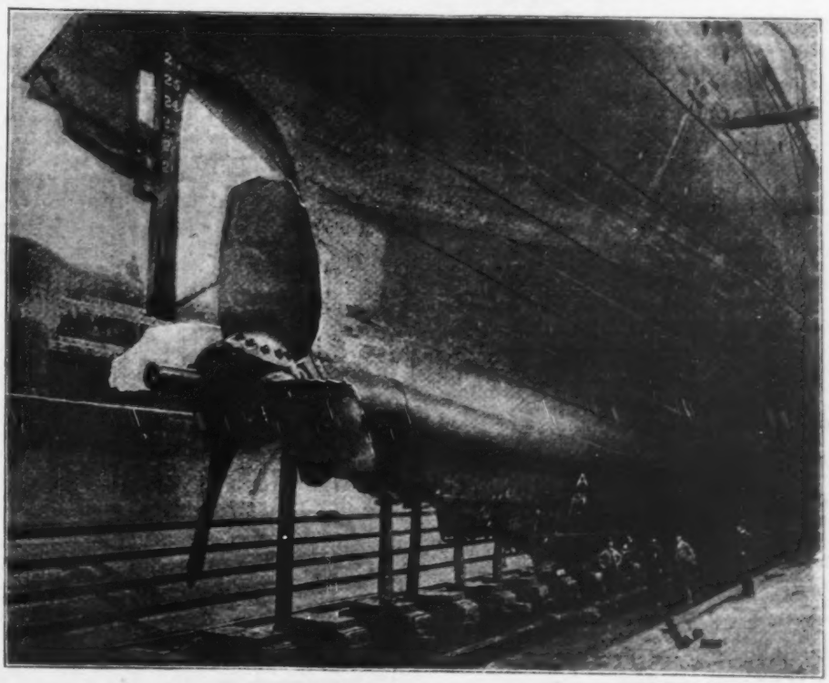
In one year, on the chief Italian railroad, 500 engines met with injuries requiring immediate repair; 350 good engines are annually found to have met with mishaps; likewise 200 "mountain and special" engines. Thus, in twelve months accidents of some nature occur to over 1,000 locomotives of the 1,280 in service—a high percentage. The combined running of all the engines amounts to some 20,000,000 miles per annum.

So the Italian locomotive engineer can expect usually, with pretty certain correctness, one accident to his machine for every 15,000 miles run. As to his average life on the road, it is statistized at 18 years (including the time spent as fireman). I am sorry to say that his average age at death is but slightly in excess of the life of the locomotive, namely, only 42½ years. One would have thought the driver of sunny Italy, almost always in the fresh air, in a climate noted for its salubrity, the resort of invalids from less genial climes, would have been longer lived. But it is not so. W'r.

Turin, June 3, 1892.

THE RAISING OF THE STEAMSHIP "EIDER."

The "Eider," one of the North German Lloyd steamers, was built in 1884 by the Fairfield Engineering Co., of Glasgow. She is 430 ft. long, 46 ft. 9 ins. beam, with 18 ft. draft (when empty). The hull is divided into eight water-tight compartments. Her weight, with engines, is about 5,700 tons. The engines are of 7,000 HP. and of the triple expansion type, giving the vessel an average speed of 17 knots. She has accommodations for 1,298 passengers and a crew of 168. As will be remembered, she ran ashore in a fog on the Isle of Wight on Jan. 31. Below we give in brief an abstract of the raising of



AFTER PART OF THE HULL OF THE NORTH GERMAN LLOYD STEAMSHIP "EIDER"

(From Photograph Taken in Dry Dock.)

the "Eider," for which and the accompanying illustration we are indebted to the "Zeitschrift des Vereines Deutscher Ingenieure."

The causes of her running ashore, as ascertained by the German Government Commission, were, 1, an increased declination of the compass, caused by the starting of the dynamo machines in the evening, 2, the current in the tide, and 3, an incorrect calculation of the distance run. As soon as the vessel had struck, her engines were reversed full speed; but instead of getting her clear, the ship, which at first lay at right angles to the coast, swung around nearly

parallel to it, whereby her keel was chiefly damaged at the stern by striking remnants of a former wreck. The hold began to fill with water, and her stern settled upon the reef.

The "Nordische Bergungs-Verein" in Hamburg and the "Neptun" Salvage Co. in Stockholm, combined to undertake the raising of the "Eider." The wrecking boats of these companies are very strongly built, and have the usual equipment of powerful pumps. Examinations by the divers showed that the heavily damaged stern of the vessel had imbedded itself to a depth of about 14 ft. into slippery blue clay, while her stern had settled upon ground of a more compact nature. No holes of much size were found. The divers then started to patch up the holes by inserting boards between the plates of the hull, then closing the remaining crevices with wooden wedges. The accompanying engraving shows one of these patches clearly near the point marked A, where the keel is torn away. Meanwhile much of the cargo was removed. The pumps were now set to work at the compartment aft of the engine-room, and the existence of at least one large hole ascertained. To locate it the divers were sent under water again while the pumps were working, but with no success. Then it was tried to pump compressed air into some of the compartments, for which purpose the walls of those had to be braced. By this time an immense quantity of mud had dissolved in the water, making it impossible for the divers to use their electric lamps, so that they had to feel their way through the engine-room of the ship and take the dimensions for braces, etc., in the same way. The difficulties of this work were increased by the accumulation of mud in the hold, and it took three weeks for 100 men to remove the mud and slush from the hold of the vessel after she had been raised.

The divers had noticed that a deep channel in the ground had been formed along the vessel's stern, which might have been caused by the motions of the ship or the suction of the pumps. They were averse to entering this cavity, however, as one of their number on a former occasion had lost his life by a cave-in of a similar formation. Finally the captain of one of the wrecking boats and a diver ventured into it. The pumps were operating, and suddenly the captain's foot was caught in the current and drawn into a hole of the hull. After the combined efforts of the two men had freed him, the dimensions of the hole were taken. Above water, a suitable patch was constructed, fitted with packing and screwed on below, in doing which the captain's arm was caught between the patch and the exterior of the hull, and only extricated by considerable effort of both men.

With the closing of this hole the main obstruction to clearing the ship of water and filling the compartments with compressed air was removed. The combined action of the pumps, including those of the "Elder," now succeeded in raising the vessel's stern. Our view shows the hull of the "Eider" at the dry-dock at Southampton.

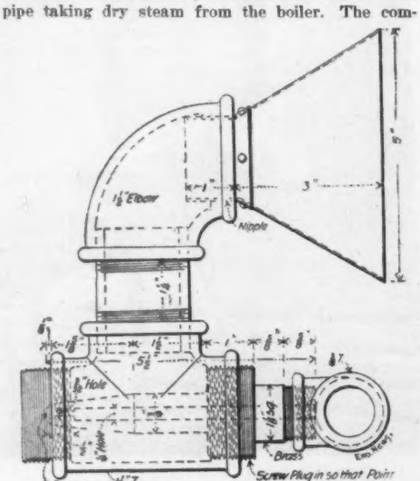
PASADENA & MOUNT WILSON RAILWAY.

A brief description of the proposed railway from Pasadena to the summit of Mount Wilson, in California, one of the prominent peaks of that part of the coast range known as the Sierra Madre, was given in our issue of March 26, and we give below some further particulars, taken from articles in the "Californian Illustrated Magazine." The Sierra Madre summits, the highest of which this railway will ultimately reach, have an annual tourist traffic of 6,000 in their present comparatively inaccessible condition, as compared with 3,000 up Mount Washington, in New Hampshire, prior to the building of the Mount Washington rack railway, while the Sierra Madre range has also a resident population of 200,000 in its immediate base and in the adjacent valleys, within less than four hours' railway journey from the new line. The city of Pasadena, the starting point, is 843 ft. above sea level, and has a population of 10,000, and Los Angeles, with an approximate resident and transient population of 70,000, is within 30 minutes' ride. Prof. Eliot, of Harvard University, visited the range recently in connection with the establishment of a permanent astronomical observatory on the site of the present experimental station.

From Pasadena to the starting point of the mountain railway is only three miles in a direct line, but the distance would give an average grade of 4.33%. A railway to Altadena has already, in seven miles of track, overcome over half of the ascent and two-thirds of the direct distance. From Altadena, the last station on the Los Angeles Terminal Ry., an electric railway will be built to the first section of the mountain railway, which will be a double track cable road, operated by an electric motor, power being furnished by a neighboring waterfall. The cars will be counterbalanced, and there will be a rack rail for safety purposes. This line will run to the Echo Mountain Hotel, at an elevation of about 3,500 ft. above sea level. The second section will be about six miles long, with a maximum grade of 7%, and terminating at a new hotel, at an elevation of about 6,000 ft. above sea level. From this point a further extension can be built along the mountain plateau, when desired. This part of the road will be operated by electricity on the trolley wire system, and it is intended to use the Pullman double-deck electric cars of the pattern illustrated in our issue of Oct. 31, 1891. The first section is under contract, grading is in progress, and it is expected to be completed early in the autumn, after which the second section will be proceeded with. The Mount Wilson railway will take about 12 miles of track in making the ascent of 4,700 ft., the grade averaging about 7%. The Mount Washington railway ascends about 3,700 ft. in 3½ miles, with an average grade of about 20%. The Rigi railway ascends 4,368 ft. in 5¼ miles, with an average grade of 14.3%, and the Mount Pilatus railway ascends 5,344 ft. in less than three miles, with a grade of 40%. These three latter roads are rack railways, and a rack for safety purposes will probably be used on the heavy grades of the Mount Wilson railway. Prof. T. S. C. Lowe is President and Mr. I. J. McPherson is Chief Engineer of the Pasadena & Mount Wilson Ry. Co., with offices at Pasadena, Cal. The company has a capital stock of $600,000.

SMOKE PREVENTION ON MICHIGAN CENTRAL LOCOMOTIVES.

The accompanying cut shows a simple arrangement for blowing air into a locomotive firebox which is in use on Michigan Central locomotives, and was designed by Mr. C. E. Smart, General Master Mechanic. There are three of these jets placed on the front side of the firebox, and all are connected to a pipe taking dry steam from the boiler. The combination with the jet of the funnel for aiding the flow of air by the current caused by the forward motion of the locomotive is novel, to us at least, and doubtless has much to do with the efficiency of the device. Mr. Smart informs us that by the use of this device he is able to reduce the amount of smoke thrown to a minimum, as compared with any other similar device in use.



Steam Jet Smoke Consumer for Locomotive Firebox, Mich. Cent. R. R.; C. E. Smart, General Master Mechanic.

TESTS OF FULL-SIZE STEEL EYE-BARS.

The accompanying record of tests on full-size eye-bars of mild steel, made by the Phoenix Iron Co. for the new 100-ton floating derrick at the ship yard of the William Cramp & Sons Ship and Engine Building Co., must possess great interest to every one who is interested in the use of structural steel. The great ductility and elongation of the bars under the breaking loads are evident at a glance, and the appearance of the several fractured surfaces showed that the metal was of extremely tough and fibrous character.

Two of the bars are of unusual size, and there are few testing machines in the country that could break them. But the powerful machine of the Phoenix Iron Co. which we described and illustrated in our issue of Jan. 10, 1891, has a capacity of 2,400,000 lbs., and can handle such bars with ease.

Tests of Full-Size Steel Eye-Bars Rolled and Manufactured by Phoenix Iron Co.

Bar No.	1	2	3	4
Section, nominal, ins.	4×1¼	5×1¼	8×¾	7×2¼
L (original), ft.	24.380	33.160	20.620	29.650
L (after breaking), ft.	28.500	38.430	33.500	33.540
E (elong. taken in), ft.	21.000	33.160	25.000	25.0 0
E (original + elong.), ft.	24.420	38.460	28.470	28.410
Head A.				
Dimensions, ins.	7.46 × 1.22	7.30 × 1.14	12.24 × 1.22	10.46 × 2.00
Excess, %	.73	31.6	57.4	.45
N ins.	3.24	3.76	6.20	5 24
O ins.	3.74	3.68	6.14	5.24
Pin hole diam., ins.	3.44	3.94	5.56	4 90
Pin hole elong., ins.	3.84	4.80	6.40	6.42
Head B.				
Dimensions, ins.	6.92 × 1.22	7.54 × 1.20	12.10 × 1 16	10.43 × 2.02
Excess, %	60.4	43.1	48.1	.45
M ins.	3.46	3.70	....	5.24
O ins.	3.46	3.84	....	5.22
N ins.	3.24	3.76	6 20	5.24
Pin hole diam., ins.	3.44	3.94	5.56	4.90
Pin hole elong., ins.	4.00	4.70	7.02	6. 6
F, ft.	.12	.2	6.27	6.6
Section, actual, ins.	4.24 × 1.24	5.18 × 1.22	7.0 × 1.20	7.0 × 2.06
Area, sq. ins.	5.26	6.32	0.43	14.42
Area, of fracture, sq. ins.	2.16	3.53	3.99	7.23
Elas. limit (by gage), lbs.	195,000	228,000	300,000	280,0 0
" " lbs. per sq. in.	37,070	36,076	38,900	38,300
Ult. st'gth (by gage), lbs.	315,000	390,000	535,000	885,0 0
" " lbs. per sq. in.	59,800	63,100	58,700	61.4 0
Elong. in 12 ins., ins.	4.60	2 80	4.30	4.50
" " " " " %	38.3	23.3	35.8	37.5
" in distance, E, ft.	3.42	5.30	3.47	3.41
" " %	16.3	10.	13.8	13.04
Reduction of area, %	50.	44.1	58.50	49.8
Fracture	Ang., Silky,	Half-cup, Silky,	Cup, Silky,	Ang., Silky.
"				

THE GRANULATION OF IRON ORE BY MEANS OF CRUSHERS AND ROLLS.*

Having no business interest in any of the various machines used for granulating ores, my remarks on the subject are prompted solely by my desire to contribute toward the determination of the best apparatus such information as I have been able to gather, partly from personal experience and observation, partly by discussing the subject in its different bearings with men practically engaged in the separating and crushing business.

The Cyclone pulverizer, with which I have been, of late, in a measure identified, together with the whole tribe of its competitors for fine grading, be they called ball or cylinder mills, pulverizers, disintegrators, or what-not, are entirely out of the question here to be considered. Such fine grinders are wasteful and unsuitable when it is not pulverization (i. e, destruction of crystals) but granulation (separation of crystals) that is desired, and the product is required to be as uniform in size and as free from dust as possible.

I may add also, as a preliminary proposition, that it would be unfair to condemn sweepingly any of the various machines employed in the preparation of magnetic ore. Each case should be intelligently judged on its own merits, according to its own nature, and it may be found that in its proper sphere a machine may justly be called successful, which, outside of this field, is an absolute failure.

We have learned from Mr. Hoffman that the Sturtevant mill at the Croton mines crushed a wonderful quantity of ore at a cost of 22 cts. per ton, of which only ½ to ⅝ represented the expense of renewals. But if the same mill be put to work on a hard, finely crystalline ore, such as that of the Benson mines, the repairs and renewals would go up to such a figure as to show the machine to be out of its proper province.

* Abstract of a paper by Mr. Axel Sahlin, M. E., read at the Lake Champlain meeting of the American Institute of Mining Engineers, June, 1892.

Again, at Chateaugay, where the ore is rather friable and its crystallization is clearly defined, it is practicable to finish the granulation on a multiple crusher which machine would prove utterly inadequate on a close-grained New Jersey magnetite. The ideal way of preparing a magnetic ore would be to detach the different crystals from each other without further injuring them. What we must practically aim at is, therefore, granulation to the size required for the special ore in question, with the reduction below that size of as small a percentage as possible. There are three weighty reasons for this rule: First, it is a waste of power to reduce the particles finer than necessary; second, the fine particles of gangue will coat the granules of magnetite and the magnetic dust will coat the granules of gangue or tails, and thus heads will come out lower and tails higher in iron than necessary; and third, dust will fill the air, cut the bearings, heat the journals, and finally force a shut-down for repairs.

Pulverization should be to a separator-man what black slag is to a blast-furnace manager or red-shortness to a steelmaker. It should be shunned. And yet how poorly are we equipped to prevent it. To show what actual granulation means, I collected one-half ton of magnetic ore, made up from various samples, and thus fairly representing the average, and had the same crushed in two successive crushers and two sets of rolls. The jaws of the first crushers were set to crush to 1½-in. mesh; those of the second to about ¾-in. mesh. The first rolls were set about 3-16 in. apart, while the second rolls were drawn up almost face to face so as to reduce to the 10-mesh (0.075 in.) screen, with square opening. The ore was sent over this screen after each pass, and the rejections were delivered to the next machine, until the whole was reduced. The ore was then sized. I also obtained a sample of Port Henry ore, crushed by means of the Sturtevant mill. This ore was also run over the identical sizing-screens used for the ore granulated by means of crushers and rolls. The results of both treatments are given below:

	Crushers and rolls.		Sturtevant mill.	
Size of particle.	Lbs.	Per cent.	Lbs.	Per cent.
10–16 mesh..	310	31.	22½	22.5
16–24 "	216	21.	21¼	21.25
24–40 "	79	7.9	9¼	9.25
40–60 "	175	17.5	59½	2.5
Above 60 mesh....	209	20.9	15½	15.5
Loss..	17	1.7	2	2.
Total....	1,000	100.	100	100.

This test, even as carried out, decides in favor of the crushers and rolls. But the conditions are altogether favorable to the Sturtevant mill, because the powerful exhaust fan connected with the mill has evidently drawn off all the fine particles. The ore, as received by me, was absolutely clean and free from dust, but, at the same time, I have the direct information that the rapid accumulation of "worthless" dust in the collecting room is a source of serious loss and embarrassment. Moreover, the Port Henry ore crushed in the Sturtevant mill is a clean, clearly defined, coarse, crystalline magnetite, containing only a small percentage of dust-producing materials; while the heterogeneous mixture treated in the above experiment by the rolls did not carry over 30 to 38% of iron, and contained, besides, a large amount of dust producers, such as feldspar, olivine and apatite, all of which remained in the sample, when it was sized. These considerations have strengthened me in my preference for gradual reduction, as compared with the direct granulation. Samples of the latter operation, as effected by the Gates granulator, look very well, but, unfortunately, no figures bearing on this treatment are available.

Another point in favor of crushers and rolls is the smaller amount of power required for a certain hourly production. A 20-in. Sturtevant mill, stated to have a capacity of 20 tons per hour, with the requisite auxiliary machinery, is compared below with a crusher and roll plant of similar capacity. It is assumed that both plants reduce the ore to 10-mesh size.

	Crusher and roll HP.	Sturt. mill. HP.
24-in. by 14-in. coarse crusher.....	20	20
Two 5-in. by 20-in. fine crushers.....	20	—
Three pair rolls.....	45	—
20-in. Sturtevant mill.....	—	110
One pair rolls.....	—	15
Elevators and conveyors.....	10	10
Transmissions (30 per cent).....	29	46
Total	124	201

In this estimate of power, the figures quoted by the manufacturers of each machine have been accepted. It is probably about as fair one way as the other, and makes a showing of 41% in favor of crushers and rolls. In a day's run of 20 hours, the 77 HP. saved represents a saving of $6.93 or about 1¾ cts. per ton of ore crushed, calculating 3 lbs. of coal per HP. per hour and coal at $3 per ton.

As to repairs, it is more difficult to find a basis of comparison between the two systems. Mr. Hoffman's record of ½ ct. per ton for the Sturtevant mill could hardly be lowered by other machinery. On the other hand, I have it on good authority that at Port Henry the wear on the cups alone amounted to one new set for every 600 tons of ore ground. Now these cups are said to weigh about 800 lbs., and their cost can certainly not be less than 3 cts. per lb., or $24 per set, which is equal to 4 cts. per ton for grinding cups alone, not to mention screen-blocks, collars, and occasional re-babbitting of bearings, etc. The life, on hard ore, of a pair of 26-in. steel tires, costing about $200, averages, as nearly as can be ascertained, from one to two years. Using three pair of rolls in the above assumed 20-ton plant, which will actually run 20 hours per day during 250 days, crushing yearly 100,000 tons of crude ore, and estimating the average life of the tires to be 1½ years, one set of new tires would at this rate be required for every 50,000 tons of ore crushed. The cost of tires in this case will, therefore, amount to 0.4 ct. per ton. On one particular pair of rolls, which I have had opportunities, off and on, to observe, there have been no repairs required during 15 months of active service, and the tires look good for at least another 15 months. In general practice, however, repairs on rolls will no doubt run somewhat higher. If jaw-crushers be rightly constructed, wear on the same should at least not come higher than on the rolls.

The above considerations, confirmed also by observation, have made me an advocate of gradual reduction, at least for hard ore. This being adopted, the next point is to make a judicious selection among the numerous modifications and improvements of the original Blake crusher and Cornish rolls, which are at our disposal, and almost daily present themselves in new and varying forms.

The only too common way to select crushing machinery has been to look at the price-list. Engineers need not be told of the folly of this method of selection. The cheap machine will rapidly become very expensive, should it not possess the qualities required for the work, and, on the other hand, a good machine at a rather high price will soon pay for itself, if it occasionally saves us a few days of a shut-down for repairs. A jaw-crusher should be of ample proportions to admit freely the largest lumps coming from the mines. The number of working parts should be as small as possible; the wearing-surfaces large enough, well protected, lubricated, and made of suitable material; and, above all, the wearing-parts should be easily got at and readily exchanged. A breaking-point should be established. I was forcibly reminded of this a short time ago, by seeing a large crusher, the jaw of which, a piece weighing not less than 8,000 to 12,000 lbs., had been broken twice. The area of the fracture must have been nearly 300 sq. ins. The metal was evidently of good quality, but this expensive and ponderous casting was clearly the breaking-point in this crusher, which should have been so proportioned as to break in a cheaper place. In some types of crushers the problems above referred to have been solved in a very satisfactory manner. The ends of the toggles, as well as the bearings on which they rest, are made corrugated, so as to be exposed to rolling friction only. The bearings are formed of loose steel locks, resting in recesses cast in the jaw, pitman and frame. The bolts holding the cap of the pitman are selected for breaking-points.

The swinging-jaw of a crusher may either be oscillated around a point above the crushing-face, as in the original Blake crusher, or below the same, as in Krom's design; or, it may receive a parallel motion, as is the case in the Buchanan machine. There are, also, more complicated arrangements for working this jaw, as in the Brennan crusher, where one jaw practically works a second one placed in front of the first, or, as in the Rockaway crusher, where both jaws are made movable and receive a differential motion. Moreover, a number of narrow jaws may be placed side by side, and worked alternately, so as to reduce the vibration of the machine. There is little doubt but that these crushers, for a time at least, give good results; but they all suffer from the vital fault of complication and increase in the number of working-parts.

If this is to be avoided, we are, therefore, forced back to the type presenting the smallest number of moving parts, which is that of the original Blake crusher. But it is better practice to pivot the swinging-jaw below the crushing-face than above it as in the Blake. For, at the upper part of the jaw a comparatively small part of the work is done, since the points of contact between the rock and the crushing-jaws are there few, while, as comminution progresses, the points of contact are multiplied, and the work is proportionately increased. Our aim should therefore be to get the shortest stroke and the greatest leverage at the lower part of the jaw, where the work is the heaviest. Another important advantage will follow the transposition of the swinging-center, namely, the variation of the opening at the bottom of the crusher will thus be reduced, and a more even product will be secured.

The number of strokes or revolutions per minute should be as great as practicable. As many as 375, or even 400 can readily be made by a 10×20-in. crusher, providing the oscillating parts are light enough. Every added stroke proportionately increases the efficiency of the machine. The swinging-jaw should be built as light as is consistent with safety. It should be made of steel, and cast hollow, the shell being thoroughly braced by means of ribs, allowing every pound of metal to be placed just where it will do the most good. The construction of the crushing-faces has a great influence on the cost of renewals. Chilled cast iron has long been the rule. Bars of rolled steel, hard and soft, are substituted in some crushers, the bars being placed edgewise one on top of the other. I would call the attention of crusher manufacturers to Hadfield's steel as a valuable material for crushing-faces. In a vibrating machine, like a crusher, it is well, wherever possible, to rely on wrought metal for taking tensile strain. A sectional frame, held together by amply strong bolts, is therefore a good arrangement, not likely to give any trouble. At the same time such a frame can be made comparatively light without decreasing the efficiency of the machine.

Rolls, like crushers, must be driven at a good rate of speed, if high efficiency is demanded, since the capacity is proportional to the number of square feet of crushing surface passing the line of contact in a unit of time. A peripheral velocity of 600 to 700 ft. per minute is found to be entirely practicable. Such a speed, however, makes it necessary to discard the levers and counter-weights used on the original Cornish rolls, and substitute springs, or eventually, rubber cushions, or solid breaker-blocks, as the weights, when once set in motion, would never have time to regain their equilibrium, but would be continually jumping. The springs, however, should not bear on the main tension-bolts, as, in such case, considerable force would be required to adjust the rolls. It is better to inclose the springs, preferably a whole nest of smaller springs, between two washers, and to draw these washers so far together with special bolts that the whole box will act as a rigid, inelastic block, until the maximum working pressure is reached, when, for the first time, further compression of the springs will take place, relieving the rolls. It is also important that the axle of the movable and rigid rolls should never become oblique under any application of strain. It is a good arrangement to attach the movable journal boxes to a pair of strong levers, firmly keyed on to a heavy shaft, so that excess of strain on one journal will cause both bearings to yield uniformly. As on crushers, so on rolls, it is all important that the bearings should be large, well protected from dust, and perfectly lubricated.

The crushing-faces, or tires, of a set of rolls require more attention than those of a crusher. The latter, generally speaking, are good until worn through, while on the roll-tires the wear must be uniform, so that the rolls remain circular, and all pits, grooves, and depressions in the face may be avoided. A uniformly hard metal, a feed that can be adjusted to deliver more or less ore at any given point of the face, and, above all, close and intelligent observation, are the best means for prolonging the life and increasing the efficiency of a set of roll-tires. Chilled iron tires are losing ground. Inequality in depth and hardness of chill, and the brittleness of the metal, are against them. Once untrue, a chilled tire can only be "trued up" by use of the emery wheel, or slow-cutting tools. The great majority of men engaged in granulating ore, with whom I have discussed this question, have emphatically expressed themselves in favor of rolled or hammered steel tires. These tires are costly in first outlay, but make a good showing for economy when estimated according to the wear per ton of ore reduced. To split a tire into two rings is not advisable, especially since we have, of late, in this country mills which can roll a tire 16 ins. wide. The joint between the two rings is apt to form a weak point on the face, and wears faster than the inner section of the tire. If a steel roll should wear out of round, which it is far less liable to do than a chilled tire, it may be dressed in a few hours. For driving the rolls, belts are preferable to gears. The latter wear quite rapidly, and allow no give or spring in the motion of the rolls. Both rolls should be driven so as to avoid any slip of the material entering between them, but a greater amount of power may advantageously be applied to the rigid roll. For feed regulator, the old-fashioned shaking trough, an overfall pulley, and a feed paddle-wheel carrying the ore over its top, all work well when properly set, but some arrangement by means of adjustable scrapers should be contrived to regulate the flow of the ore at any given point of the face of the rolls, as this is the most efficient means to keep the tires true.

Of all the machinery going to make up a crushing plant the elevators are most subject to wear. Experience has long condemned link-chains and screw-conveyors as perishable and therefore worthless. If ver-

tical elevation is indispensable, belts, to which elevator buckets are riveted, answer fairly well; but wherever horizontal and inclined conveyor-belts, traveling over concave carrying-rollers, can be used, they are no doubt preferable to any other contrivance now employed for conveying ore.

The variety in construction of screens for sizing ore gives a wide range for the selection of the proper model. The plates or screening surfaces should be exchangeable with a minimum expenditure of labor and time. They should also be reversible, as the wear is invariably greater at the end where the ore enters the screen. Provision should be made for regulating the time during which the ore remains in the screen. Moreover, the plates should be such that they will not clog up, but will afford escape for foliated crystals of minerals like hornblende and mica, on which the crushing machinery can make little or no impression.

The form which, in my opinion, best fills the above requirements, is a hexagonal prismatic frame, fitted with perforated steel plates, having diagonal slots. The plates on such a screen can be removed without disturbing the center, and, being rectangular, they can be reversed. The time during which the ore remains in the screen can be perfectly controlled by the variable pitch given to the shaft, which should be adjustable, up and down. For very fine screening, wire cloth or very thin plates must be used. They may be conveniently fastened with staples to a light hard-wood frame, which is clamped in turn to the screen-center. Punched steel plates with oblong slots are preferable to wire netting, partly on account of greater wearing capacity, partly because they keep cleaner.

An annoying uncertainty exists as to the meaning of the term mesh. Some engineers signify by the expression "10-mesh" screen, a screen with openings 1-10 in. square; others mean a screen with ten wires equally spaced in the length of one inch. No distinction is made between wire screens and plate screens, or between round, square and oblong openings, in talking about ore crushed to give a mesh. It would be advantageous if some standard could be adopted to give a basis for comparisons. But so long as there is no fixed standard, care should be taken to give, in all descriptions, such full particulars as will preclude misunderstanding or uncertainty.

At least as important as the selection of good crushing machinery is the judicious arrangement of the machines in designing the plant, of which they form parts. As experience accumulates, we can look forward to far better and simpler arrangements than we now have; but, new as is the business, some general principles have demonstrated themselves for our guidance. All working machines should be placed on solid foundations and under no circumstances should they be bolted to the upper floors of a shaky frame structure. The shafting and transmissions should be reduced to a minimum. One line of shafting, if well placed, will suffice for driving a very large plant. If great output is aimed at, the plant should be built in independent sections, as small as the capacity of machines of practical working size will justify. Because our first crusher may have a capacity of 30 to 40 tons per hour, it is not expedient to place, dependent on this and on each other, a long string of subsequent machines, the collapse of any one of which will paralyze the whole plant. It is better to provide an additional first crusher and devide the plant into two independent lines. Each individual machine may not by this arrangement be worked to its full capacity, but at the end of a year the output of the plant will be found far greater.

Bucket-elevators should be avoided, at all events until behind the first rolls, but preferably altogether. Screening-surfaces should be of ample, in fact, excessive size. Where ore is carried by gravity down chutes or slopes, it should be made to wear on itself. No metal, however hard, will long resist the impact of the small particles of ore which act not by heavy blows, but by continuous abrasion. Instead of making inclined planes of metal, it is therefore better to construct succession pockets or steps, which quickly fill themselves with ore, and keep filled up, making their own repairs without any care, expense or delay.

DISTRIBUTION MAINS AND FIRE SERVICE.*

Inefficiency of the water supply is the statement that comes to us again and again as a stereotyped sentence in current reports of large fires. These reports emphasize the fact that it is always important that each public water supply system shall be a good and efficient fire controlling system.

In a majority of the towns and cities that have built water supplies under municipal ownership, it is probable that the desire for fire protection was the strongest incentive to the general public and the chief influence that carried the vote for the issue of bonds to pay for water-works.

Fire may be a grand spectacle to one who has no personal interest other than to enjoy its grandeur; it may interest one who studies the plan of contest to control it, but it is a waste for which there is no recompense, a discouragement, as of ill fate, to the loser, and awful in the extreme when human lives are engulfed in the ruin.

All the great cities of the civilized world transmit in their histories lurid stories of great devastations, and the sum of fire losses in great fires of American cities alone seems fabulous.

A committee of the National Board of Fire Underwriters estimates the average annual waste of values by fire during the last decade as exceeding one hundred million dollars, and claims that the annual loss is increasing.

Boston has had five great historic fires, St. Louis three, New York two, Philadelphia two and Pittsburg, Albany, San Francisco, Washington, Portland, Chicago, Lynn, Spokane and Seattle, successively, and a host of small cities have seen the fire fiend cut his broad swath through their midst. Are failures, so often occurring, due in any large degree to a lack of knowledge of the principles and proportions of a good fire hydrant service?

New fire systems are being constantly planned in the new cities and old systems are being constantly extended, so that it may be profitable to consider just how far the successive steps in planning a new or extending an old system are governed by simple rules requiring only easy mathematical demonstrations or computations.

Force of Hose Jets.—The making of a good fire hydrant service is the form in which the problem comes to the young and enterprising city, and the maintenance the form in which the problem comes to the older city. Towns or cities of less than 10,000 inhabitants have comparatively few three-story or other buildings requiring fire protection that reach 40 ft. in height. Cities of 10,000 to 25,000 inhabitants have comparatively few four-story or other buildings that exceed 50 to 60 ft. in height, and these heights cover their municipal, court and hospital buildings. The large cities have buildings 80, 100 and 125 ft. or more feet in height. As a general rule, streams that have force to reach a vertical height of 80 ft. from the ground answer well nearly all requirements of small cities and the suburbs of large cities and also the business sections of cities where buildings do not exceed 60 to 70 ft., say five to six stories in height. The high office buildings of large cities require a special adaptation of the fire service.

Our present interest does not extend to such hose jets as were given at the Centennial test in 1876, when 1⅞ in. streams were thrown 195 ft. vertically, or to such a stream as was shown at the Syracuse Convention of Firemen in 1885, reaching 316 ft., horizontally, from a 1⅝-in. nozzle.

Those were maximum test and tournament streams rather than for practical fire service.

Volumes of Hose Jets.—A thorough knowledge of the volume of water and rate of discharge of the fire streams to be used is a first essential in the preparation of a plan of a fire system.

To illustrate the value of this we will compute and tabulate a series of serviceable streams having force to reach to given heights, 70 to 100 ft. vertically, and from nozzles of 1, 1⅛, 1¼ and 1⅜ ins. diameters. The units, gallons or million gallons per twenty-four hours are of such frequent and familiar use in water supply statements and mental comparisons that the computations are also stated in these terms and may consequently be easily compared with capacities of distribution pipes, stand-pipe tanks and pumping machinery.

Table No. 1 covers the ordinary range of forces of jets and volumes of discharges, and will indicate what provision per jet must be contemplated in the flow of the distribution pipes.

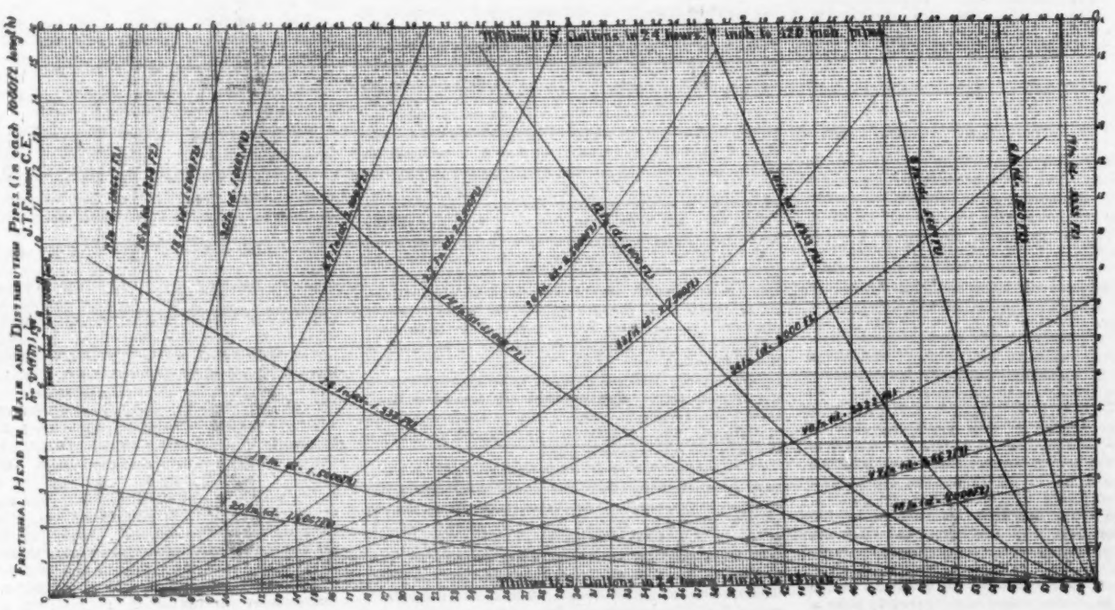


DIAGRAM SHOWING HEAD LOST IN SMOOTH PIPES PER 1,000 FT. OF LENGTH.

*A paper by J. T. Fanning, C. E., read before the American Water-Works Association at New York, May 18, 1892.

Table 1.—Data of Practical Fire Streams.

Vert. ht. of stream, ft.	Diam. of nozzle, in.	Pressure at play pipes, lbs.	Horl. proj. of streams, ft.	Gall. per min.	Gall. per 24 hrs.
70	1	46.5	59.5	203	292,208
70	1⅛	44.5	61.3	249	358,520
70	1¼	43.0	63.0	306	440,613
70	1⅜	41.5	77.0	368	530,149
80	1	59.0	67.0	230	331,200
80	1⅛	55.5	69.5	281	404,700
80	1¼	53.5	72.4	343	493,900
80	1⅜	51.5	74.4	410	590,400
90	1	79.0	76.6	267	384,500
90	1⅛	72.0	78.5	324	466,600
90	1¼	68.5	81.0	388	558,800
90	1⅜	65.5	82.6	468	674,000
100	1	125.	88.0	311	447,900
100	1⅛	103.	89.0	376	541,500
100	1¼	93.	92.0	460	662,500
100	1⅜	88.	92.0	540	777,700

We observe in the table, for instance, that if we use a 1⅛-in nozzle, a stream of 70 ft. vertical force discharges at a rate of ⅜ million gallons, a stream of 80 ft. force discharges at the rate of 4-10 million gallons, a stream of 90 ft. force discharges at the rate of 5-10 million gallons, and a stream of 100 ft. force discharges at the rate of 2-3 million gallons, approximately; also if we use 100-ft. streams the 1¼-in. nozzle discharges at the rate of 2-3 million gallons, and the 1⅜-in. nozzle discharges at the rate of ¾ million gallons, approximately.

The above jets may be from hose connected directly to the fire hydrants or equivalent jets from steam fire engines, which take their water from the hydrants. The volume of the jet will be the same for the same nozzle and height of stream.

Rated capacities of steam fire engines, which is perhaps one-third greater than their ordinary rate of work at fires, are substantially as follows:

3d size,	550 gals.	per min.,	or	792,059 gals	per 24 hrs.
2d "	700 "	"		1,208,750 "	"
1st "	900 "	"		1,296,096 "	"
1 ext.	1,100 "	"		1,584,118 "	"

In the preparation of the plan of distribution there must be an estimate, with wise forethought, of the number of these strong streams or the number of these steamers that will work at their utmost speed and draft at the same time.

Friction Losses in Hose.—In the above table of data of practical hose streams, the volumes of water discharged per jet, 200 to 550 gallons per minute, were for stated pressures at the play pipe.

In providing for this pressure, due allowance is to be made for friction losses in each hose according to the streams of greatest discharge which are to be used.

The loss of pressure or its equivalent loss of head (h) in the hose may be found by the formula

$$h = v^2\,(\text{lm})\,\frac{l}{2\,g\,d}$$

In this formula, as ordinarily used, for friction per 100 ft. of 2½-in. hose there are the following constants:

2½-in. diameter of hose d=.20832 ft., and sec=.0434 sq. ft.

Lenth of hose l=100 ft., and 2g=64.4.

The variables are:

v=velocity in feet per second.

h=loss of head in feet per 100 ft. of hose.

m=a coefficient previously found by a series of experiments.

The velocity, v is found from the given discharges of the jets through the given diameter of hose.

A series of these friction losses for given discharges in jets, when tabulated, is a ready aid in arriving at the pressure that must be provided at any given hydrant. In Table No. 2 are given friction losses in 100-ft. lengths of rubber lined. smooth, 2½-in. hose.

Table 2.—Head and Pressure Losses by Friction in Hose.

Disch. per min., galls.	Veloc. per sec., ft.	Coefficient m. (a)	Head lost. ft.	Press. lost, ft.	Value of n. (b)	Galls. per 24 hrs.
200	13.072	.00450	22.89	9.93	119.6	288,000
250	16.388	.00446	35.55	15.43	120.0	360,000
300	18.558	.00442	46.80	20.31	120.9	432,000
347	21.677	.00439	61.53	26.70	121.1	499,680
350	22.873	.00439	68.48	29.73	121.2	504,000
400	26.144	.00436	88.83	38.55	121.5	576,000
450	29.408	.00434	111.80	48.52	121.8	648,000
500	32.675	.00432	137.50	59.67	122.1	720,000
520	33.982	.00431	148.40	64.40	122.12	748,800

These frictions are for given volumes of flow in the hose and the velocities respectively due to those volumes and are independent of size of nozzle. The changes in nozzle do not effect the friction in the hose if there is no change in velocity of flow, but a larger nozzle with equal pressure at the nozzle augments the discharge and velocity of flow, and thus materially increases the friction loss in the hose.

(a) In formula $h = v^2\,(\text{lm})\,\frac{l}{2\,g\,d}$.

(b) In $v = n\left(\frac{r\,s}{n}\right)^{\frac{1}{2}}$ $n = \left(\frac{2\,g}{n}\right)^{\frac{1}{2}}$

Values of (n) are deduced from the elaborate experiments on Fire Streams, by John R. Freeman, C. E., given in Trans. Am. Soc. C. E., November, 1889.

To illustrate further the frictional effect of change of nozzles take from Table No. 1 the same streams and tabulate in No. 3, their friction losses in each 100 ft. of smooth, rubber lined 2½-in. hose.

Table 3.—Friction Losses for Given Streams.

Diam. ins.	Height ft.	Pressure at Play Pipe, lbs.	Friction per 100 ft. Hose, lbs.	Friction per 100 ft. Hose, Net Head, ft.
1	70	46.5	10.75	24.77
1	80	59.0	13.00	31.10
1	90	79.0	17.70	40.78
1	100	130.0	22.50	51.14
1⅛	70	44.5	15.50	35.71
1⅛	80	55.5	19.40	44.70
1⅛	90	72.0	25.40	58.52
1⅛	100	103.0	33.90	77.85
1¼	70	43.0	22.75	52.42
1¼	80	53.5	28.40	65.43
1¼	90	68.5	35.90	82.71
1¼	100	93.0	57.75	86.98
1⅜	70	41.5	32.50	74.88
1⅜	80	51.5	40.00	92.16
1⅜	90	65.5	51.40	118.43
1⅜	100	88.0	72.00	165.89

Loss of pressure (p) and head (h) in rubber lined, smooth 2½-in. hose may be found approximately by the formulas

$$p = \frac{l\,q^2}{4150\,d^5} \quad \text{and} \quad h = \frac{l\,q^2}{1801\,d^5}$$

in which

p=pressure lost by friction, in pounds per square inch.

l=length of hose in feet.

q=gallons of water discharged per minute.

d=diameter of the hose in inches, 2½ ins.

h=friction head in feet.

The coefficient would be decreased for rougher hose.

Hose Jets Compared.—The problems introduced by changes of nozzles are so numerous that it will be a convenience to assume a standard stream for this discussion, and so compare other streams with this standard, that they may be easily kept in mind.

If we assume first a standard height of 80 ft., then discharges may be from different diameters of nozzles approximately:

1-in.	stream,	230	gals.,	per min.,	rate of	.33	million gals.
1⅛	"	281	"	"	"	.40	" "
1¼	"	343	"	"	"	.49	" "
1⅜	"	410	"	"	"	.60	" "

The 1½-in. stream, with power to reach a height of 80 ft., is a good standard for a small city or the suburbs of a large city, and this discharges water at a rate of, approximately, 4-10 million gallons per 24 hours, a quantity easily remembered or multiplied for comparisons.

The loss of pressure and head for this standard stream is, in each 100 ft. of 2½-in. hose, approximately 20 lbs., or 45 ft., net, or say including friction in the hydrant, ½ ft. loss of head for each foot of hose, another quantity easily remembered or multiplied.

If we change the nozzles to 1¼ or 1¾ ins. diameter, then for the same 80 ft. height of stream we increase the friction losses on the hose to approximately 2-3 ft. and 1 ft. head respectively for each foot length of hose.

These computations show the very great difficulty of maintaining a high stream through the large nozzles unless the hose is very short, especially for a gravity or direct pressure system.

Our standard single 1½-in. stream requires approximately 56 lbs. pressure or equivalent 129 ft. head at the play pipe, and 45 to 50 ft. head for each 100 ft. length of smooth 2½-in. hose, so that for 100, 200 and 300 ft. of hose we must have available heads at the hydrant or fire engine of 106, 156 and 206 ft. respectively. If we substitute 1¼-in. nozzles for same height of stream we must have available heads at the hydrants or engine of 185, 255 and 325 ft., respectively, or we must increase the diameter of a portion at least of the long hose and save friction loss of head.

Large streams from portable water towers are most serviceable when the streams are supplied by one or more steam fire engines capable of maintaining a good pressure at the elevated nozzle. The discharge for given pressures at the nozzles are substantially as follows:

Table 4.—Volumes of Portable Tower Streams.

Pressure at nozzle, lbs.	Diam. of nozzle, ins.	Galls. per min.	Galls. per 24 hrs.
40	1	433	623,520
40	1	563	810,847
40	2	735	1,058,444
40	2	1,158	1,666,970
50	1	463	666,060
50	1	630	906,553
50	2	822	1,184,051
50	2	1,285	1,850,234
60	1	507	729,544
60	1	674	970,487
60	2	901	1,297,032
60	2	1.407	2,026,854

Number of Hose Jets Required.—Thus far the volumes and frictions of one good fire stream only have been considered. Now certain numbers of these 4-10 million gallon streams must be assumed for computations of friction losses in the main and distribution pipes of water supply systems of different magnitudes.

We will assume the judicious provision of 80 ft. fire streams for the ordinary fire service of cities having the population named to be substantially as follows:

Populations.	No. of Streams.	Rates, Millions of Gallons.
4,000 to 10,000	7 to 10	3.84 to 5.42
10,000 to 50,000	10 to 14	5.48 to 7.98
50,000 to 100,000	14 to 18	7.68 to 9.87
100,000 to 116,000	18 to 23	9.87 to 12.62

Combined Fire Service and Domestic Draft of Water.—In American cities, populations of 4,000 use for ordinary domestic purposes about 2 million gallons daily; populations of 10,000 use 6 million gallons; populations of 50,000 use 4.4 million gallons; populations of 100,000 use 10 million gallons, etc., the rate per capita increasing with the total population, and being here stated as mean daily consumption for each year.

We have for these four assumed cases combined mean rates of 4.04, 6.08, 12.08 and 19.87 million gallons, respectively, per 24 hours, as the flow in the supply mains when a fire is in progress at mid-day.

The domestic draft of water will be greater in volume in certain hours of the day, and at certain seasons of the year.

The drafts for fire service in the principal mains of the village system will be ten times the draft for domestic use, and may be always in excess until the city has a population of 80,000 to 100,000.

The excess of draft for fire service continues in the suburbs and sub-districts of cities and must be provided for in the sub-mains and distribution pipes, not less than seven standard streams in the suburbs and increasing to 10 and 12 streams as the manufacturing or commercial centers are approached and the full force of 18, 20 or 30 streams in the centers of industries, trade and shipping, according to their values and importance.

Frictions in Distribution Pipes.—From lessons of experience a maximum advisable velocity (V) of flow, or as better termed for our present purpose, a maximum advisable loss of head (h) by friction in pipes of different diameters is assumed to be as follows, using as before the formula $h = \frac{4\,\text{lmv}^2}{2\,\text{gd}}$ and d being taken in feet.

Table 5.—Maximum Advisable Losses of Head.

Diam. ins.	Veloc., ft. per sec.	Coefficient, m.	Friction in 1,000 ft. of pipe, head in ft.	Friction per mile, head in ft.	Flow per min., galls.	Flow 24 hrs., galls.
4	3.10	.00647	11.59	61.195	121,849	174,859
6	3.90	.00608	11.49	60.667	343,675	494,892
8	4.50	.00575	10.83	57.182	704,840	1,014,970
10	5.00	.00550	10.30	54.701	1,223,880	1,762,384
12	5.50	.00536	10.07	53,169	1,938,660	2,791,701
14	5.80	.00520	9.33	48.246	2,782,650	4,007,016
16	6.00	.00507	9.07	47,884	3,761,840	5,417,052
18	6.25	.00494	7.99	41,187	4,956,643	7,127,296
20	6.50	.00476	7.50	39,600	6,362,410	9,161,875
24	6.75	.00454	6.42	33,918	9,518,370	13,706,460
27	6.90	.00440	5.78	30,534	12,312,560	17,689,951
30	7.00	.00425	5.17	57,318	15,422,114	22,207,845

It may be remarked that these maximum losses of head can rarely be allowed when computing for the portions of gravity or direct pressure systems distant from the origin of the head or pressure when the hose for fire streams are to be attached directly to fire hydrants without the intervention of steam fire engines. The alternative then is to take a pipe of larger diameter.

When steam fire engines are used, an allowance must be made in computing frictions for maintaining at least 100 ft. of head in the dense residence sections to provide the necessary domestic pressure in the chamber, bath rooms and sanitary tanks.

Proportioning Distribution Pipes.—In computing for the fire service we find it advisable to begin with the hose stream in the air and work backward through nozzle, hose, hydrant and branch pipe into the distribution, so in computing for the pipe system we should begin with the distribution in each of the small subdivisions and compute the volume of the fire service there according to the surroundings and then the local, domestic, commercial, industrial, mechanical and ornamental drafts of water, allowing for growth of the local sections, then summing the volumes of those local sections into the sub-mains and then all together in the principal mains, and through this course we reach the maximum rate of outflow from the pumping machinery of the direct pressure system, or from the reservoir or tank stand-pipes.

To find the capacities of the several distribution pipes to supply fire streams alone, divide column six, of rate of flow in the above table of maximum allowable frictions by $^6/_{10}$, the assumed rate of flow, in million gallons, for the stream, and we have:

Diameter of pipe, ins.	6	8	10	12	14	16	18	20	24	27	30
No. of streams..	1	2	4	7	10	13	18	25	35	44	55

The domestic and other drafts must of course be allowed for in the final determination of diameter of pipe. These numbers of streams are stated for pipes which receive their water from one end, only, but if the flow comes freely from both ends of the pipe toward hydrants on the same section then the capacity of the

pipe is doubled and the number of hydrants on the same section may be doubled.

If we compare a given flow from one end of the pipe to an outlet at its center, with the same total flow from both ends to the outlet we find the loss of head in the second case to be but one-fourth the loss in the first case.

This matter of double flow toward fire hydrants is of significant importance in the fire service system and it is a strong argument against many of the dead ends that might be made contributors of flow to hydrants.

Friction Heads for Given Numbers of Streams.—The friction losses in the pipes for the given number of streams are to be summed, beginning with the hydrant branches, then in the distribution pipes which supply them, then in the sub-mains, and then in the principal main, back to the pumping machinery, or reservoir.

Such frictions are tabulated for pipes of different diameters, in Table No. 6, and are for a flow in one direction. The volumes may apply to combined streams or to equal combined streams and domestic drafts.

Table 6.—Head Lost by Frictions in Smooth Pipes, in each 1,000 ft. of Length.

Friction Heads in feet, for given Diameters and Numbers of Streams.

No. of 4 million gall. streams.	Total discharge, million galls.	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	18-in.	20-in.
1	4	7.8	1.65	0.62	0.24	0.12	0.5	.....	.....
2	8	27.0	6.90	2.30	0.92	0.43	0.22	.....	.....
3	1.2	.....	15.10	5.00	2.00	0.93	0.48	0.27	0.13
4	1.6	.....	.....	8.70	3.50	1.64	0.84	0.53	0.25
5	2.0	.....	.....	12.17	5.32	2.47	1.24	0.78	0.40
6	2.4	.....	.....	.....	7.40	3.49	1.77	1.03	0.58
7	2.8	....	.....	.....	10.20	4.70	2.38	1.37	0.77
8	3.2	.....	.....	.....	13.05	6.06	3.07	1.74	0.97
9	3.6	.....	.....	.....	.....	7.60	3.87	2.11	1.24
10	4.0	.....	.....	.....	.....	9.40	4.74	2.63	1.54
11	4.4	.....	.....	.....	.....	11.20	5.72	3.64	1.83
12	4.8	.....	.....	.....	.....	13.15	6.74	3.70	2.16
13	5.2	.....	.....	.....	.....	.....	7.84	4.33	2.54
14	5.6	.....	.....	.....	.....	.....	9.08	5.04	2.93
15	6.0	.....	.....	.....	.....	.....	10.40	5.74	3.36
16	6.4	.....	.....	.....	.....	.....	11.80	6.54	3.80
17	7.8	.....	.....	.....	.....	.....	12.45	7.40	4.24
18	7.2	.....	.....	.....	.....	.....	.....	8.25	4.73
19	7.6	.....	.....	.....	.....	.....	.....	9.13	5.28
20	8.0	.....	.....	.....	.....	.....	.....	10.05	5.83
21	8.4	.....	.....	.....	.....	.....	.....	10.90	6.40
22	8.8	.....	.....	.....	.....	.....	.....	11.70	7.00
23	9.2	.....	.....	.....	.....	.....	.....	.....	7.47
24	9.6	.....	.....	.....	.....	.....	.....	.....	8.33
25	10.0	.....	.....	.....	.....	.....	.....	.....	9.00

A diagram is presented on page 42 illustrating the above table from which the friction head in each 1,000 ft. of pipe, for given discharges may be taken.

The diagram will show by inspection the frictions of the combined fire and domestic flows in the several diameters of pipes within the range of ordinary velocities of flow in public water supply systems.

(To be continued.)

THE CHICAGO UNION TRANSFER RY. CO.

In our issue of Feb. 8, 1890, we gave a full illustrated description of this proposed enterprise, which has for its object the removal of the enormous freight transfer business from the streets of Chicago and its concentration on a tract of land just west of the city limits, lying between the Chicago & Calumet Terminal and the Chicago & Western Indiana Belt railways. Two obstacles have thus far prevented the carrying out of the enterprise as proposed. One was that it was found impossible to secure all the land in the tract on which it was proposed to carry out the scheme. The other was the refusal of the railways to take hold of the enterprise. As explained in our previous article it was intended that each of the 20 railways entering Chicago should subscribe for the stock of the Chicago Union Ry. Transfer Co. to the amount of $100,000, and thus that all the profits of the enterprise should go to the railway companies taking part in it. It is still hoped, however, that united action by the railway companies may be secured. The Chief Engineer of the Chicago Union Transfer Ry. Co. is Mr. W. S. Jones and the President is Mr. Samuel W. Allerton. Among those interested in the enterprise are Gen. Jos. T. Torrence, a prominent promoter of Chicago railway terminal schemes, and Mr. Albert Stickney, the head of the Chicago, St. Paul & Kansas City Ry. system, now the Chicago & Great Western.

A part of the plan of the promoters of the enterprise was to secure the removal of the Union Stock Yards from their present location to the central portion of the tract, which has been acquired by a new company, the National Stock Yards Co. This part of the plan bids fair to be carried out at an early date, and it may be the entering wedge for the success of the larger scheme.

INTERNATIONAL IRON AND STEEL PRICES.

The "Iron Age" gives some interesting details under this head in its issue of June 6, in evidence of an alleged tendency of iron prices to rise abroad and fall in this country, so that the tendency is toward equilibrium. It is, of course, an admitted fact that this must come in time, for the simple reason that the great stores of iron-making materials are on this continent, and from nowhere else can the rapidly increasing demand of the world be met. That we are making great strides in that direction seems to be indicated by the following table, which we reproduce verbatim, adding only the last column. The most notable exception to the prevailing tendency in this table is steel rails, which have been held up to an increasing price in this country by a powerful combination, though they have fallen materially in England. The comparative price of steel billets in this country and abroad strongly indicates that there is no good reason why steel rails should be over $23 to $25 in this country.

Articles.	April, 1885.	May, 1892.	Incr. or decr.
No. 1x anthracite foundry pig iron, at tidewater, U. S.	$17.50	$15.50 to $16.00	−1.50 to 2.00
No. 1 Scotch pig iron, f. o. b. shipping port	$10.40 to 12.00	10.00 to 13.00	+0.25 to 1.00
Gray forge pig iron, Pittsburg	14.00	12.75	−1.25
Cleveland (Eng.) mill iron, f. o. b.	7.94	9.35	+1.42
Bessemer pig iron, Pittsburg	17.00	14.00	−3.00
English Bessemer pig, f. o. b.	10.69	12.15	+1.46
Refined bar iron, Pittsburg	33.60	35.84	+2.24
Staf. com. marked bars, f. o. b.	27.34	30.96	+3.62
Steel rails, at mill in Pennsylvania	26.00	30.00	+4.00
English steel rails, f. o. b.	23.17	19.44	−3.73
Steel billets, Pittsburg	....	22.25	....
English steel billets, f. o. b.	....	20.04	....
Steel wire rods, Pittsburg	....	32.00	....
English steel rods, f. o. b.	....	32.19	....

Gray forge pig at Southern furnaces in this country is now selling at $8.75 to $9, which is below the price of Cleveland gray forge in England. Welsh furnace coke is selling at $4.73, gross ton, f. o. b., as against $1.00, net ton, or $2.13 gross ton, for Connellsville coke.

In Germany a combination of the steel-rail manufacturers forced prices in 1890 to a maximum of $40.46 per metric ton, but, encountering at length the opposition of the government, prices were gradually forced down, until $27.37 was touched in the latter part of last year. During 1891 German forge pig iron fluctuated between $12.13 and $12.61, Bessemer pig $13.80 and $15.47, and foundry pig $16.42 and $17.37.

French prices in April, 1891, of foundry and forge pig iron were $12.02 and $11.40 repectively per metric ton, and bar iron and beams at Paris were sold at 32.30 and $34.20. In August bar iron was reduced to $30.40 and beams declined to $32.30, where they have since remained. The French iron market has been singularly stable for some time.

Belgian prices are very low on manufactured iron, but not on pig iron. The following prices, per metric ton, are published as prevailing on April 1, 1892:

Bessemer pig iron	$13.77
Basic pig iron	11.40
Charleroi forge pig iron	9.50 to 10.45
Steel rails for export	20.90
Merchant bars for export	21.85
Ditto for home consumption	22.80 to 26.60
Beams for export	21.85
Ditto for home consumption	22.80 to 24.75
Slip angles	24.70
Furnace coke	2.47

When the day does come that iron and copper raw materials are as cheap here as abroad, it is a tolerably safe prediction that our export trade in manufactures will make a better showing than it does now.

Boston's new building law requires all buildings hereafter erected over 70 ft. in height to have floors of iron or steel beams and masonry arches. No building may be erected over 125 ft. in height.

Wrought iron tie-plates are being used to some extent in India, and contracts have recently been placed in England, by the India Office, for steel rails, fishplates and bolts, and wrought iron tie-plates. Flange or T rails are being more and more used on Indian railways, their advantages being evidently recognized by the government engineers, but there is still an extensive mileage of track laid with the double-head or bull-head rail and cast iron chairs, involving much needless material and expense.

The railways of Italy are owned by the government, and leased to operating companies for a term of years. During the year June, 1889, to June, 1890, there were 137 miles built, including 22 miles of steam tramway in Sardinia, owned by the Sardinia Steam Tramway Co. The total receipts of all railways during the same period amounted to $48,037,650, and the lengths of the different systems on June 30, 1890, and the receipts per mile for the year ending on that date were as follows:

	Miles.	Rec. $
Adriatic Company	3,280	6,408
Mediterranean Company	2,004	7,915
Sicilian Company	444	3,465
Sardinian Company	2.5	....
All others	1,248	....
Total length	8,1.0	.....
State railways	....	2,550
Sardinian railways.		
Sardinian Company	....	1,280
Secondary railway company	....	422
Other railways	....	2,075
Average of all railways	....	5,947

A new form of throttle valve for locomotives has been brought out by the Schenectady Locomotive Works, Schenectady, N. Y. There are two small double-seat balanced valves in separate casings side by side, the valve stems being connected by a bar. The lever which raises the valves is not attached to the middle of the bar, but to a point near one of the valve stems. One valve is therefore opened first, the bar then striking a lug or stop on the valve casing, and the further upward stroke of the lever opens the second valve. This allows of a very slight opening of the throttle to move the engine, and the double valve is expected to be more easily kept tight and more easily handled than ordinary valves of large diameter.

Pig iron manufacture in New Zealand is to be encouraged. The New Zealand Government is offering a bonus of $5 per ton on the production of the first 500 tons of pig iron of marketable quality manufactured in the colony from magnetic or titaniferous iron sand or iron ore, all material, fuel and fluxes, being the produce of New Zealand. The bonus must be claimed before March 31, 1893.

The lever movements in the large signal boxes at the London terminals of the Southeastern Railway at London Bridge, Charing Cross and Cannon Street, are said to amount to 32,000 per 24 hours.

An underground railway is being built at Glasgow, Scotland, by the Glasgow Central Ry. The line runs from east to west, across the city, the direction of the greatest traffic, and extends into the western suburban residence district. The length is about 7½ miles, and the cost of construction will be about $5,000,000. The depth of ground varies from a few inches to 100 ft., and for the greater part is about 20 ft. The heaviest grade is 1.25%, and the sharpest curve about 2,000 ft. radius. There will be 4,350 ft. of tunnel, 12,284 of tunnel built in open cut, or "cut and cover;" 3,570 ft. of open cut. The excavation will aggregate 1,170,175 cu. yds. There will be 13 stations, ten bridges over the track, three bridges over roads, and a masonry and iron-work bridge and viaduct at the River Kelvin.

The Royal Trans-African Railway is progressing slowly. Writing under date April 21, the British Consul at Loanda said that the line had been opened for 140 miles, and that a train left and arrived at Loanda every day. As yet, however, it was of little use to the mercantile community, as it passed through a barren district, and will be of little use until it reaches Cassange, the center of the coffee district. This year the rains have, he says, been exceedingly heavy, and great damage has been done to the railway works, the loss being estimated at $400,000. The works are going on very slowly, and some of the principal engineers in Lisbon think it doubtful if the line will be completed to Ambaca for four or five years. Nearly all the material used by the railway comes from Belgium. The passenger traffic is already large, and it is surprising that so many natives travel by it. To bring coffee from Cassange to Loanda formerly cost in carriage $35 to $40 per ton, having to be carried about 40 miles by na-

tive carriers to Dondo, thence 180 miles by steamers and launches to the mouth of the Quanza River, and thence 50 miles by sea to Loanda. By rail it is calculated to cost $17.50 to $20 per ton, which means a considerable saving, especially to the planters. In our issue of June 2 it was stated that the line had recently been opened as far as Cassange, 300 miles from the coast.

In the article on the Venturi meter in our issue of July 7, on p. 16, is is stated that: "The coefficient showed a remarkable constancy, whether applied to a rough meter and 9-in. pipe, or a smooth meter and 1-in. pipe." We are informed that the sizes of the pipe should have been given as 9 ft., and 1 ft., instead of 9 ins. and 1 in. The error was not ours, but in the copy as furnished us, as the reference was only to an experimental meter, the context fitted sufficiently well with either dimensions.

The reports of the Buenos Ayres Great Southern Ry. and the Buenos Ayres Western Ry., for the second half of 1891, show that the Great Southern has 20% of its recently opened lines in territory practically undeveloped for railway traffic, and its grades are heavier than those of the other line. The Western Railway consists chiefly of a main line without unremunerative branches, but with some feeders, and it runs through almost level country, while the territory which it serves was settled and developed at an earlier period than that served by the Great Southern. The above table gives a comparison of the operation of each line for the half year referred to.

Railway.	Miles.	Train miles.	Tr. miles per mile.	Average per mile per day.—Pass'rs.	Tons.	No. of animals.	Trains.	Gross earnings.	Operating expenses.	Net rcpts.
Great Southern.....	974	998,257	1.026	5.76	1 72	4.73	5.08	$12.60	$5.50	$6.40
Great Western.....	338	534,117	1.577	17.38	5 15	4.85	8.58	14.50	7.50	7.00

The report on the Natal Government Railways, South Africa, for the year 1891, has recently been issued by Mr. D. Hunter, General Manager. The total revenue amounted to $2,861,480, and the expenditure $1,860,120, leaving a net revenue of $1,001,360. The gross revenue has decreased, as compared with preceding year, 6.67%. The working expenditure has been reduced 10.65%. The average interest paid by the colony on railway account is 4%, so that the railways earned during the year a sum sufficient to cover the whole working expenses and interest, and, in addition, contributed a sum of $95,720 toward the general revenue of the colony. The gross working expenditure amounted to 65% of the revenue. The total length of railway opened for traffic at the end of the year was 365¾ miles, thus: Maintained at cost of revenue—Lines to Glencoe, 259 miles; Glencoe to Newcastle, 37 miles; Dundee branch, 7¾ miles—total, 303¾ miles. Maintained at cost of construction: Newcastle to Charleston, 36 miles; Free State Junction to Van Reenen's 35¾ miles—total, 71¾ miles. Grand total, 375½ miles. The Newcastle and Charlestown section was opened for traffic in August and the Orange Free State branch to Van Reenen in November, 1891.

A national railway school was proposed by Mr. Hermann Crueger in a paper recently read by him before the Engineers' Association of Virginia. He proposes a preparatory school, where all elementary branches would be taught, including English, writing and spelling; and in addition, shorthand, typewriting, telegraphy, train dispatching, railway book-keeping, and other subjects. The advanced course would be, practically, a railway engineering course, differing little from those now given in the engineering schools of the country, except that the training for railway work might be more distinctly kept in view. All candidates for admission to the railway school would be subjected to a rigid physical examination. Mr. Crueger is Chief Clerk to the Chief Engineer of the Norfolk & Western R. R. Co.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

MIDDLESEX VALLEY.—The local papers state that work is being rapidly pushed on this railway from Naples to Stanley, N. Y. A portion of the northern end of the line is now about ready for operation.

COLUMBUS TERMINAL & CONNECTING.—Work has been commenced upon this terminal railway at Columbus, O. The object of the road is to furnish terminal facilities for the Norfolk & Western R. R.

CONCORD & MONTREAL.—An effort is being made to induce this company to build a branch from Exeter, N. H., to Hampton Beach.

OTTAWA & GATINEAU VALLEY.—Work is now in progress upon the fourth 10-mile section of this railway, and it is expected that the entire 40 miles will be in operation by September. As soon as this is finished work will begin on the fifth 10-mile section.

BEECH CREEK.—This company proposes to issue $250,000 of its secured mortgage bonds and $250,000 of the $1,000,000 of stock just issued to pay for the extension from Kerrmoor to Mahaffey, Pa., which is about completed.

CANADIAN PACIFIC.—A press dispatch from Niagara Falls, N. Y., says: "It is expected very soon that the Canadian Pacific will commence the construction of its branch railway between Woodstock, Ont., and this place. It is said that the contract for the steel bridge across the Niagara River has been let to a Buffalo firm. The bridge will be a large and handsome structure and the approaches on both sides of the river will be constructed with an eye to beauty as well as durability. The approach of the Canadian side will be built on the site selected last year, but there will a slight change in the one selected on the American side of the river. In order to have the road rapidly completed between Woodstock and the Canadian end of the bridge the work will be let in small sectional contracts. Preparations for the building of this part of the road are quietly going on, and it is thought that in three weeks all the contracts will be let and work commenced on the different sections simultaneously. Mr. Ramsay, the company's engineer, is now making the final survey between Woodstock and this place, and he will complete his work by the end of the present week."

CUMBERLAND VALLEY.—Surveys have been begun for a line from Newville, Pa., to the Broad Top coal fields.

WABASH.—The extension from Montpelier, O., to Hammond, Ind., has been all graded and tracklaying has been commenced at Montpelier. It is expected that about two miles of track per day can be laid. The ballasting will follow the tracklaying as close as possible.

PLYMOUTH & MIDDLEBORO.—This railway from Plymouth to Middleboro, Mass., 16 miles, has been completed and will soon be opened for traffic.

COLUMBUS, LIMA & MILWAUKEE.—Preparations are being made to begin tracklaying on the section from Lima to Defiance, O.

MEAD & LAUREL RUN.—It is stated that this Pennsylvania railway will be extended 13½ miles. Pres., B. E. Cartwright, Newark, N. J.

BANGOR & AROOSTOCK.—The contract for building this Maine railway has been awarded to C. P. Treat, of Chicago, Ill. The road as surveyed will run from Brownville to Van Buren, Me., with branches to Ft. Fairfield and Ashland, Me., a total length of about 230 miles. Pres., A. A. Burleigh; Ch. Engr. Moses Burpee; both of Houlton, Me.

Projects and Surveys.

CANADA.—The Canadian House of Commons has granted subsidies of $3,200 per mile for the following railways: To the Inverness & Richmond Ry. Co. (or any other company undertaking the work), for 25 miles from Orangedale or Broad Cove, on the Cape Breton Ry., in lieu of the subsidy of $50,000 already granted.—For a railway from a point on the Intercolonial Ry., through the Stewiacke Valley, on a line which will afford facilities for communication with the iron mines at Springside, Upper Stewiacke, and Musquodoboit settlements, 25 miles, in lieu of subsidy previously voted.—To the Buctouche & Moncton Ry. Co. for 32 miles of railway from Moncton to Buctouche, the balance remaining impared of the subsidy previously voted.—For 40 miles of railway from Truro, or a point between Truro and Stewiacke, to Truro or to Windsor.—To the Restigouche & Victoria Ry. Co., for 15 miles from Campbellton toward Grand Falls.—For 75 miles of railway from Sand Point, Shelburne Harbor, to a junction at or near New Germany on the Nova Scotia Central Ry., and to Annapolis, in lieu of subsidy to a like amount granted by 53 Vic., chap. 2, for the same length of railway from Shelburne and from Liverpool toward Annapolis.—For 28 miles of railway to complete the connection between Sydney and Louisburg.—For 12½ miles of railway connecting the works of the New Glasgow Iron, Coal & Ry. Co. with the I. C. R. at Eureka.—For 20 miles of railway from Woodstock to Centreville, N. B.—To the St. John Valley & River Du Loup for 15 miles of their railway from the north end of the line, subsidized by the 53 Victoria, chap. 2, to the town of Woodstock.—To the Woodstock & Centreville Ry. Co., for six miles of their railway from the west end of the 20 miles subsidized by the 50-51 Victoria, chap. 24, to the International boundary between the province of New Brunswick and the State of Maine, in lieu of the subsidy granted by the 53 Victoria, chap. 2.—For a railway from the north end of eleven miles, for which a subsidy was granted by 53 Victoria, chap. 2, to Plaister Rock Island, for 3 miles.

ALTOONA SHORT LINE.—The profiles for this railway from Everett to Ore Hill, Pa., with branches, a total of 40 miles, are nearly completed. Pres., S. L. Langdon, Philadelphia, Pa.

CENTRAL R. R. OF PENNSYLVANIA.—Chartered in Pennsylvania to build a railway from Middleton to Steelton, Pa., 6 miles. Pres., Wm. H. Ulrich, Hummelstown, Pa.

PENNSYLVANIA CENTRAL.—This company is stated to have secured the franchises, etc., of the old Bellefonte & Eastern R. R. and is making surveys of its proposed line from Bellefonte to Watsontown, Pa., 80 miles. Local papers state that the line will be built in the interest of the Philadelphia & Reading R. R.

ALTOONA & PHILLIPSBURG CONNECTING.—Chartered in Pennsylvania to build a railway from Janesville, Pa., to Phillipsburg, Pa., 20 miles; Pres., Samuel P. Langdon, Philadelphia, Pa.

Southern.—Existing Roads.

WINCHESTER & BEATTYVILLE.—J. H. Pearsons, Ch. Engr., Beattyville, Ky., writes us that this railway is to run from Beattyville, Ky., up the North Fork of the Kentucky River to the Kentucky Union Ry., about two miles above Lumber Point, a distance of 5¾ miles, with a branch to coal mines 1 mile long. The surveys have been finished and the contracts let to Thompson Bros., of Ashland, Ky., who have begun work. The work will be light, with a considerable amount of pile trestling. The object of the road is to open up the lumber and coal interests of Beattyville and the South Fork of the Kentucky River. It is expected to have the line completed by Nov. 1, 1892.

BOSTON & ALBANY.—This railway, which has been operated as a tramway for some time from Round Lake to McDonald, Ga., 16 miles, is being extended to Moultrie, Ga., about 16 miles further. The company is doing its own work and expects to have the line completed by April 1, 1893. The route is through a farming and timber country and the principal business of the road will be in timber, naval stores, cotton and melons. Supt., C. W. Pidcock, Round Lake, Pa.

JACKSONVILLE, ST. AUGUSTINE & HALIFAX RIVER.—Work is reported begun on the extension from New Smyrna to Titusville, Fla. Work has been in progress for some time from Daytona to New Smyrna, Fla.

NASHVILLE, CHATTANNOOGA & ST. LOUIS.—Work is to be begun at once on the proposed branch of this railway from Huntsville to Hobb's Ferry. It is expected to have the line in operation by Jan. 1, 1893.

PADUCAH, TENNESSEE & ALABAMA.—The contract for grading the extension from Hollow Rock to Lexington, Tenn., 30 miles, has been let to Sullivan, Johnson & McLaughlin, of Memphis, Tenn. M. T. Carthe & Co., have the contract for the bridging.

MORRISTOWN & CUMBERLAND GAP.—Surveys are in progress for an extension from Bean Station via Rogersville, to Bristol, Tenn.

Projects and Surveys.

FLORIDA, KEY WEST RY. & BRIDGE CO.—This company, which was recently chartered in Florida, proposes building a railway from Miami or some other point in Dade Co., Fla., to Key Largo and thence along the Keys and shoals to Key West. The distance from Key Largo to Key West is 112 miles, of which 28½ miles is water. The surveys have been completed. Chas. Delano, Glenwood, Fla., is at the head of the enterprise.

ALEXANDER & RICH MT.—Chartered in West Virginia to build a railway from Alexander, W. Va., up the Buckhannon River to Rich Mt. Among the incorporators are W. G. Arden, Henry L. Davis and C. E. Bushnell, of Philadelphia, Pa.

GEORGIA, CAROLINA & NORTHERN.—Surveys are reported to be in progress for branch to the Lethonia and Stone Mt. granite quarries in Georgia.

PINE BLUFF & SWAN LAKE.—The survey has been completed for this railway from Pine Bluff to Swan Lake, Ark., 16 miles, and it is stated that work will begin at once.

Northwest.—Existing Roads

PORT ARTHUR, DULUTH & WESTERN.—The contractors expect to resume work on the 15 miles of this railway from Sandy Lake to Gunflint Lake in a short time and to have the road completed to the international boundary this year.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—About 107 miles of the extension from Valley City, N. Dak., north are now under contract, bringing the line to the Cheyenne River.

FULTON COUNTY NARROW GAGE.—A press dispatch says: "Superintendent A. C. Atherton of the Fulton County (Ill.) Narrow Gage R. R. authorizes the statement that D. J. Thayer, Ch. Engr., of Charlton, Ia., has gone to Bates, Sangamon County, Ill., to look up a line between Bates, Springfield and Havana. The object of running a line to Bates is to connect at that point with the St. Louis, Alton & Springfield R. R. This is the proposed line by which the Narrow Gage expects to reach Alton and St. Louis.

JACKSONVILLE SOUTHEASTERN.—The grading has been completed on the Chicago, Greenville & Southern R. R. and tracklaying will begin at once.

DULUTH, SOUTH SHORE & ATLANTIC.—The contract for building the 30-mile extension from Iron River Junction, Mich., to West Superior, Wis., has been let to Henry & Balch, of Minneapolis, Minn.

Projects and Surveys.

CHICAGO, LAKE GENEVA & NORTHWESTERN.—It is announced that the preliminary surveys have been begun for this railway from Libertyville to Portage, Wis.

NORTHEASTERN NEBRASKA IMPROVEMENT CO.—C. D. Smiley, South Sioux City, Neb., Pres., writes us that this company will make an effort to construct its line from South Sioux City to Homer, Neb., 16 miles, this fall. The surveys have all been made. Sec., R. B. Daley, South Sioux City, Neb.

MIDLAND PACIFIC.—This company has been reincorporated in South Dakota. S. L. Tate, of Sioux Falls, S. Dak., is President.

GOODYEAR, NEILLSVILLE & NORTHERN.—It is stated that this company proposes to build most of the proposed line from McKenna to Williston, Wis., 12 miles, this season. Pres., C. A. Goodyear, Tomah, Wis.

JOLIET, DEKALB & NORTHERN.—Gen. Man., E. Soule, of Joliet, Ill., writes us that the preliminary survey has been completed for this railway from Joliet to DeKalb, Ill., 56 miles, and that contracts will be let soon. The work will be light; maximum grade 1%. There will be one large bridge. Pres., Wm. L. Ellwood, DeKalb, Ill.

Southwest.—Existing Roads.

PAN-AMERICAN.—The "Manufacturers' Record" says: "William Davis, Gen. Supt. of the Pan-American Ry., reports that tracklaying has been finished on the first ten miles from Victoria to the Guadulope River. The line is located to the Nevas River, 75 miles, and preliminary line run to Brownsville, Tex. It is expected to let contract for the entire line within the next 60 days."

ST. LOUIS, KENNETT & SOUTHERN.—It is stated that an extension of this railway is being built from Kennett, Mo., west to Caruthersville, Mo., 24 miles, under the name of the Pemiscat R. R.

ST. LOUIS, CAPE GIRARDEAU & FORT SMITH.—The surveys have been completed for a branch from Puxico, Mo., to Poplar Bluff, Mo., 20 miles, and it is stated that it will be constructed this year.

KANSAS CITY, NEVADA & FT. SMITH.—Gen. Man. Gentry is reported as saying that it is the in-

tention of the company to extend its road at once from Hume, Mo., to Pittsburg, Kan., and that the work will be completed in 90 days.

Projects and Surveys.

KANSAS CITY, ELDORADO & SOUTHERN.—Chartered in Missouri to build a railway from West Eldorado to Rich Hill, Mo., 30 miles. Among the incorporators are: E. H. Brown, Gerard, Kan., John T. Morrison, Medway, Kan., and T. H. Anderson, Nevada, Mo.

Rocky Mt. and Pacific.—Existing Roads.

SANTA FE, PRESCOTT & PHOENIX.—A press dispatch from Albuquerque, N. Mex., says: "The contractors for the Ash Fork and Prescott extension of the Santa Fe route have distributed their first consignment of rails along the new road, and will begin laying steel within a few days. Twenty-seven miles of grade is ready for steel, and ties are being distributed nearly that entire distance. Trains will be running to Prescott by September. The gap between Prescott and the northern terminus will be closed within a year, while connection with Tucson and Nogales will be made by November, 1893."

SPOKANE & NORTHERN.—This company has let the contract for an extension from Little Dalles to Northport, Wash., to J. R. Marks & Co.

SAN FRANCISCO & NORTH PACIFIC.—A force of about 75 men are now at work on the extension from a point 1.97 miles west of Guerneville, Cal., to a tract of redwood timber, about 3 miles.

Projects and Surveys.

PORT GARDNER, LAKE STEVENS & EASTERN.—This company has been chartered in Washington to build a railway, telegraph and telephone line and docks, and gas and electric light plants.

BIG HORN & SOUTHERN.—The Indian Committee of the United States Senate has reported favorably on the bill extending the time for constructing this railway through the Crow Indian Reservation in Montana.

LAKE CHELAN RY. & NAVIGATION CO.—This company has completed surveys for a railway from the head of Lake Chelan, Wash., to Horseshoe Basin, a distance of 26 miles. The object is to give the Chelan mining district an outlet to the Columbia River at Chelan Falls, Wash.

CALIFORNIA MIDLAND.—It is announced that this company will issue mortgage bonds to the amount of $7,000,000 to provide for the construction of its line from Stockton, Cal., south, through the San Joaquin Valley.

Foreign.

JALISCO-PACIFIC.—The officers of this company are: Pres., Wm. J. Palmer; Vice-Pres., Geo. B. Moffatt; Treas., Walter Hinchman, and Sec., John Pratt. The railway from Manzanillo to Colima, Mex., 59 miles, has been secured, and it is proposed to build from Colima to Guadalajara, a distance of 166 miles. The whole line is to be completed within three years, but it is proposed to build at once a section from Guadalajara to near Sayula, 82 miles. This section will cost $1,475,000, and the money for its construction will be secured by the sale of that amount of the first mortgage bonds on the completed line from Manzanillo to Colima held by the Mexican National Cons. Co. This company has agreed to build and equip the entire line in consideration of the delivery to it of first mortgage bonds amounting to $25,000 per mile, preferred stock amounting to $20,000 per mile, and common stock amounting to $25,000 per mile. The company obtains a subsidy of $2,316,000 from the Mexican Government and $503,000 of 6% bonds from the State of Jalisco.

MEXICAN SOUTHERN.—The "Mexican Financier" says: "Construction work is being pushed rapidly. Grading has been completed to Oaxaca, and station grounds at that point for the temporary station buildings are being graded. These buildings will be erected at once, so as to be ready to open as soon as the rails are laid to the city. Permanent station grounds have not yet been decided upon, but doubtless will be before work is commenced on the extension to Tehuantepec. At this writing track is laid to a point between kilometers 290 and 300 from Puebla, and is progressing at the rate of a kilometer or more per day. As the work is in a very narrow canyon and on a heavy grade progress is comparatively slow; another reason for this being the large number of bridges necessary to put in over the various crossings of the Tomellin and San Antonio rivers. Taking everything into consideration, however, it looks very probable that rails should reach Oaxaca by the latter part of September. Station buildings at the intermediate stations are all up, so that there will be little or no delay in opening for traffic as soon as the line is completed."

TEHUANTEPEC.—A press dispatch from San Francisco, Cal., says: "The Examiner" says that C. P. Huntington and Jay Gould have received a letter from President Diaz, of Mexico, declining to sell them the Tehuantepec Government R. R. It is said $8,000,000 was offered for the road. The line, which is expected to compete with the Panama road, is about two-thirds completed now, and is expected to be finished in eighteen months. The part already finished extends from Minatitlan, on the Gulf of Mexico, across Tehuantepec Isthmus to Boca del Norte. The Pacific Coast terminus will be the point of Salina Cruz. The entire length of the line will be 164 miles. This route will shorten the distance between San Francisco and New York 1,152 miles over the Panama route."

BRIDGES, TUNNELS AND CANALS.

CAMBRIDGE, MASS.—The City Engineer has been ordered to advertise for proposals for building a bridge over the railway tracks at Fresh Pond.

HAMILTON, O.—Proposals will be received until Aug. 2 for building a bridge over Crawford's Run on Lane St.

RIVERTON, VA.—Two iron bridges will be erected across the North and South Forks of the Shenandoah River.

WHEELING, W. VA.—The Wheeling & Belmont Bridge Co. contemplates constructing a steel bridge across the Black River.

TUNNELS.—The Canadian Pacific Ry. is reported to be making borings for a tunnel under the Detroit River near Windsor, Ont.

The New York & New Jersey Terminal R. R. Co. has made application to the New York City Board of Aldermen for power to construct a tunnel under 14th St., from the North to the East rivers, with a branch under Hudson St., to Chambers St., and thence to Broad and Wall Sts.

The New York & Queens Co. R. R. Co. has made application to the New York City Board of Aldermen for power to build a tunnel under the East River from 34th St.

ELECTRIC RAILWAYS.

NEW YORK, N. Y.—The Second Avenue Ry. Co. has applied to the State Railroad Commissioners for permission to use storage battery motors.

BROOKLYN, N. Y.—Franchises for electric railways have been granted to the Union Ry. Co. and the Coney Island, Fort Hamilton & Brooklyn Ry. Co.

BALTIMORE, MD.—The City & Suburban Passenger Ry. Co. will adopt the trolley system of electric traction.

ALEXANDRIA, VA.—Mr. Davis, Chief Engineer of the electric railway, will advertise for bids for the construction of the Mt. Vernon road, and also for bids for the construction of the power house, for which plans are now being prepared.

AKRON, O.—Work is in progress on a line from Akron to Cuyahoga Falls and Silver Lake, about 7 miles. The company is composed of Messrs. Parmelee, Price and Anthony, who report the sale of bonds to New Jersey parties.

ALTON, ILL.—The Alton & Suburban Electric Street Ry. Co. has been incorporated by M. Mayfield, H. C. Swift and E. G. Webster, of North Alton.

PORTLAND, ORE.—The Barnes Heights & Cornell Mountain Electric Ry. Co. has commenced construction.

SAN BUENAVENTURA, CAL.—Mr. Geo. C. Power, Engr. in Charge, states that bids varying from 20.8 to 28.1 cts. per ft. have been received and rejected as too high, for 15,704 ft. of street railway work, 42-in. gage. This is the beginning of an electric line to Nordhoff, 16 miles distant.

ELEVATED RAILWAY.

NEWARK, N. J.—The Passaic Elevated Transit Co. has been organized to build an elevated railway to Jersey City; $1,500,000; I. B. Newcombe, of New York; R. S. Harvey, of Nyack, N. Y., and W. H. Taylor, of Scranton, Pa.

HORSE AND MOTOR RAILWAYS.

WORCESTER, MASS.—Worcester & Shrewsbury Street Ry. Co.; $20,000; length ⅞ mile; Treas., H. H. Bigelow, Worcester.

BABYLON, N. Y.—Deer Park & Babylon Ry. Co.; $50,000; T. S. Bunce, of Babylon; H. R. Garden and H. H. Plummer, of New York.

ELIZABETH, N. J.—Citizens Street Ry. Co.; $53,000; F. M. Voorhees, F. C. Marsh and R. T. Potts.—West End Street Ry. Co.; T. M. Voorhees, F. H. Ball and C. W. Irwin.

NEWARK, N. J.—Railway Ammonia Motor Co.; $125,000; to operate the patents of the Standard Fireless Engine Co., of Chicago; W. A. Crombie and A. A. Rochereau, of New York; A. H. Ross, of Newark.

PITTSBURG, PA.—Morningside & Highland Park Street Ry. Co.; $35,000; Pres., H. A. Davis, Sewickley, Pa.

HIGHWAYS.

NEW YORK.—The town of Hempstead, Long Island, has passed resolutions to be submitted to Board of Supervisors, asking power to bond the town for $90,000 to macadamize the Merrick road for 5 miles.

OHIO.—Proposals for turnpike work will be received until July 18 by S. Lamb, Cy. Clk., Toledo, O.—Proposals for the improvement of Elberon road, in Cincinnati township, will be received until Aug. 3 by John Hagerty, Co. Aud., Cincinnati.

MICHIGAN.—Proposals for grading, turnpiking and ditching the Wilson state road will be received until July 20 by Wm. Mulvena, Supervisor, Alpena, Mich.

WATER-WORKS.

New England.

FARMINGTON, ME.—Contracts for the works of the Farmington Water Co. have just been closed. Water will be pumped from Sand River to a 250,000-gallon stand-pipe. There will be 34 hydrants. Construction will begin early in August.

ORONO, ME.—The people have appointed Prof. Geo. H. Hamlin, E. E. Ring, and others a committee to contract with Laughton & Clergue, or other parties, for works on the franchise plan.

TAUNTON, MASS.—The contract for laying a 30-in. main from Elder's Pond to the pumping station has been awarded to Kenneth McKay, South Attleboro, and Luther Dean, Taunton, at 71 cts. per lin. ft. and $4 per cu. yd. for rock excavation. J. J. Newman, Providence, was the highest bidder at $1.85 and $6, respectively.

Middle.

LOWVILLE, N. Y.—An engineer will be engaged to report on works.

POUGHKEEPSIE, N. Y.—The Water Commissioners have reported to the Council that new pumps are necessary at an estimated cost of $30,000.

SOUTH ORANGE, N. J.—Meters will be used on all services hereafter.

SUMMIT, N. J.—It is reported Dr. Seward Webb, James R. Pitcher, and others, have purchased 3,000 acres of land on Baltus Roll Hill, near this place, and will proceed at once to improve same, including the erection of a large water plant on the hill.

WOODSTOWN, N. J.—The Council has been authorized to issue $30,000 of bonds for works.

BELLEVUE, PA.—The Bellevue Water Co. has been incorporated; $1,000; Treas., John Johnston, Bellevue.

MAYFIELD, PA.—It is reported that the Mayfield Water Co. has been incorporated; $15,000; Directors, J. D. Stacken, Jermyn; J. J. Williams, Scranton, and others.

NEW WILMINGTON, PA.—It is reported that a company will be formed. Prof. S. R. Thompson and W. A. Clark, are interested.

STEELTON, PA.—It is reported that a franchise has been granted F. R. Gilbert, Millersburg, and others, and that the borough will rent 75 hydrants at $30 each. The supply will be from Yellow Breeches Creek or a well on an island in the same river.

WAYNESBORO, PA.—It is reported that the dam will be raised 10 ft. and an additional supply main be laid.

Southern.

MARTINSVILLE, VA.—Bonds to the amount of $30,000 have been voted.

BAYARD, W. VA.—It is reported that an electric light and water company has been incorporated with capital of $25,000.

ASHEVILLE, N. C.—Bids for pumps are wanted. See proposal advertisement.

BIRMINGHAM, ALA.—The company proposes to buy a pumping engine for the Cahaba River station.

ALEXANDRIA, LA.—G. O. Watts has received a franchise for works estimated to cost $35,000.

COLLIERVILLE, TENN.—The Collierville Water & Manufacturing Co. has been incorporated by E. K. Leake, R. F. C. Moss, and others.

NASHVILLE, TENN.—The West Nashville Water Supply Co. has applied for a contract, allowing it to buy water of the city, and pump the same to a reservoir to supply an elevated suburb.

North Central.

NORTH VERNON, IND.—Plans for works have been made.

CENTRALIA, ILL.—Works are proposed. The Council and Mayor seem strongly in favor of municipal ownership.

MACOMB, ILL.—Works will probably be built if a suitable supply can be found.

WAUKEGAN, ILL.—Plans for works will be made by John A. Cole, Chicago. Lake Michigan and driven wells are each talked of as a source.

VENICE, ILL.—It is reported that the Village Board has decided to sell the works owned by the village, and has instructed its clerk to advertise for proposals.

Northwestern.

BLOOMFIELD, IA.—Bids for building works, including the sinking of a well, are wanted until July 19. J. R. Sheaffer, Chn. W. Wks. Com.

MADRID, IA.—Works are talked of.

VAIL, IA.—The Council is considering the building of works.

O'NEILL, NEB.—The contract for works has been let to Godfrey & Meals for about $14,000.

WAYNE, NEB.—A. F. Paige, Sioux City, Ia., has the contract for works to be completed Oct. 1, at $18,000.

Southwestern.

ST. LOUIS, MO.—Bids are asked until July 26 for 2,200 tons of cast iron coated pipe, 100 tons specials, and the building of a pumping station; also Aug. 9 for a high service pumping engine and fire boilers to be located at Bissell's Point.

SPADRA, ARK.—It is reported that works are to be built.

AUSTIN, TEX.—E. W. Groves, Chf. Engr. Rd. Pub. Wks., informs us that bids will soon be invited for constructing a reservoir and power house for the new works. Winfield Bros., Chattanooga, recently received the contract for laying about 40 miles of pipe for $49,700.

BAIRD, TEX.—The Council has accepted a proposition to build works made by the Baird Water & Power Co. It is stated that work will be started at once.

CALDWELL, TEX.—The Water Works Committee wishes propositions for a franchise.

EDMUND, OKLA.—A small fire protection system is projected, including a 150,000-gallon tank on a 50-ft. tower, a pump in a flouring mill and mains and hydrants in a few streets.

CRIPPLE CREEK, COLO.—It is reported that the Cripple Creek Water Co. will at once begin to construct works.

Pacific.

BUCKLEY, WASH.—It is reported that a direct pumping system will be put in at once at a cost of $9,500. The supply will be from White River, from a point ¾ of a mile above the town.

ATHENA, ORE.—Bids will be received until July 30 for the following material and labor: 6,700 ft. 4 to 8-in. pipe; 15 gates, 15 hydrants and 11 gate boxes; 3,000 lbs. specials; laying pipe, etc.; a pumping plant and tower and tank. Engrs., Adams & Gemmel, Pendleton, Ore.; Chn. Fire & Water Com., E. R. Cox.

KENDRICK, IDAHO.—Action is being taken by citizens to secure works, it is reported.

Canada.

VAUDREUIL, P. Q.—The Council wishes bids until July 21 "for the construction of an aqueduct o na way running over seven miles in length." F. D. O. Turcotte, Secy.-Treas.

ARTESIAN WELLS.

BLOOMFIELD, IA.—Bids will be received until July 19 for sinking a well not less than 4 and not more than 6 ins. in diameter. J. R. Sheaffer, Chn. W.-Wks. Com.

IRRIGATION.

GREAT FALLS, MONT.—J. W. McKnight, H. O. Chowen and F. B. Wilcox propose to irrigate land near the Fort Shaw Military Reservation, between the Sun and Missouri rivers. A canal 20 ft. wide at the bottom, 34 at the top and 7 ft. deep is proposed and 25,000 ins. of water have been appropriated.

GLENWOOD SPRINGS, COLO.—Engr. Rosenberg has just completed plans for a large irrigating system, water to be taken from the Grand River.

NEW COMPANIES.—Southern Irrigation Co., Orlando, Fla., $25,000.

SEWERS.

BENNINGTON, VT.—McClintock & Woodford, Boston, Mass., are preparing surveys for the proposed system. J. T. Shurtleff, Secy. Com.

MONTPELIER, VT.—The Village Trustees have been authorized to investigate the question of a sewerage system.

LAWRENCE, MASS.—The Committee on Streets has recommended sewer extensions in 13 streets.

SPRINGFIELD, MASS.—The Superintendent of Sew-

ers will receive bids until July 20 for 3,155 lin. ft. of brick sewer.

DANBURY, CONN.—Bids are asked until July 20 for 3,830 lin. ft. of 10 to 18-in. pipe sewers. J. K. Wilkes, Cy. Engr.

ALBANY, N. Y.—The Board of Contracts will receive bids until July 18 for a brick and cement sewer 36 × 54 ins., with walls 8 ins. thick.

BATAVIA, N. Y.—J. J. Washburn and D. W. Tomlinson are members of the recently appointed Board of Sewer Commissioners, which is authorized to employ an engineer and have surveys and plans prepared at a cost not to exceed $2,000. We are informed by E. Kuichling, Cons. Engr., Rochester, that he has recently been connected with sewerage projects for Batavia, Oneida, Clinton and Mechanicsville, the work in the last two cases being that of revision of plans as Consulting Engineer to the State Board of Health.

COBLESKILL, N. Y.—The citizens have voted in favor of a system to cost between $20,000 and $30,000.

DUNKIRK, N. Y.—The Council has voted to construct 12-in. pipe sewers in two streets.

ELMIRA, N. Y.—The City Surveyor is preparing plans for a relief outlet for the Water St. sewer at Lake St. Bids will be asked for the construction.

ROCHESTER, N. Y.—The contract for section No. 3 of the East Side sewer has been awarded to Brayer & Albaugh, at $65,920 for open cut and tunnel, or $66,045 for entire open trench work.

TROY, N. Y.—The Public Improvement Commission has recommended that 30 × 45-in. sewers be constructed in two streets. The Board of Aldermen has voted in favor of sewers in six streets.

READING, PA.—Plans for two sewers have been accepted and the City Engineer instructed to ask for bids as soon as the specifications are ready.

SALISBURY, MD.—The Council has contracted with the Salisbury Sewer Co. for the drainage of the city.

CLIFTON FORGE, VA.—It is proposed to provide sewerage for a large portion of the town. Address Councilman Parker.

COLUMBUS, GA.—A report on the necessity of a system of sewerage has been presented by C. D. Hunt, Pres. Bd. of Health, and an ordinance prepared providing for a special election Sept. 7, to vote on the issue of bonds for $135,000.

CANTON, O.—Bids are asked until July 25 for four brick precipitation tanks. L. E. Chapin, Cy. Engr.

CONNEAUT, O.—Bids are asked until July 30 for several sewers. J. A. Brown, Clk.

FREMONT, O.—Bids will be received by the Council until Aug. 8 for the Bull Run trunk sewer.

SPRINGFIELD, O.—The Board of Public Affairs will receive bids until Aug. 1 for 15 and 18-in. pipe sewers.

FORT WAYNE, IND.—Bids are asked until July 25 for 15-in. clay pipe and a 42-in. double ring brick or iron pipe sewer. F. M. Randall, Cy. Engr.

ROCK ISLAND, ILL.—The Council has voted in favor of about six miles of sewers, estimated to cost $25,000.

WEST DULUTH, MINN.—Several miles of storm sewer will be constructed.

LEEDS, IA.—Plans are being prepared for a combined surface and sewer drainage system.

JOPLIN, MO.—Bids are asked until July 19 for sewers, three districts, including an automatic flush tank of 313 gallons capacity and two double tanks of 740 gallons each. A. F. Donnan, Cy. Engr.

ST. JOSEPH, MO.—The Council proposes to extend the Mitchell Ave. sewer, 13 × 14 ft. four ring brick, at a cost of $30,000, for which bids will soon be asked. P. B. Wright, Cy. Clk.

AUSTIN, TEX.—The Council has voted a sewerage franchise to the Lewis Mercer Construction Co. Milton Morris, Cy. Clk.

PHOENIX, ARIZ.—We are informed by W. A. McGinnis, Cy. Engr., that contracts have been awarded for a system to cost about $60,000.

ADVERTISEMENTS.—In our advertising pages will be found notices of proposals open for sewer work at Cobleskill, N. Y.; East Orange, N. J.; Indianapolis, Ind.; Ishpeming, Mich., etc.

STREETS.

SPRINGFIELD, MASS.—The City Solicitor has been instructed to push the Armory St. crossing matter so that work may begin this fall. The plan provides for grading and filling estimated to cost $61,000.

CRANSTON, R. I.—The Council has voted $10,000 to macadamize Broad St.

ALBANY, N. Y.—The Board of Contract will receive bids until July 18 for excavating, filling, curbing, flagging and cobble paving, in Orange St.

BROOKLYN, N. Y.—The lowest bid for repaving five streets with granite blocks were those of Wm. Kelly, New York. The prices were from $2.27 to $2.65 per sq. yd. for paving, and aggregate $28,421. The Commissioner of City Works will receive bids until July 19 for repaving five streets with asphalt.

BUFFALO, N. Y.—The contract for repairing William St. has been awarded to the German Rock Asphalt Co., at $124,850. The Department of Public Works will receive bids until July 25 for paving with American bituminous rock, Trinidad asphalt, German rock asphalt, dressed block medina sandstone, and brick.

NEW YORK, N. Y.—The Department of Public Works will receive bids until July 21 for grading, flagging and granite block paving, five contracts.

TROY, N. Y.—The Board of Aldermen has voted to pave two streets with granite blocks and three with asphalt.

NEWARK, N. J.—The Street Commissioners will receive bids until July 20 for ten contracts, including granite blocks, 37,060 sq. yds.; Trinidad asphalt, 15,640 sq. yds.; cobble stone, 1,740 sq. yds.; Belgian bridging, 11,000 sq. ft.

ROCKVILLE, MD.—The Town Council has voted to receive proposals for 700 to 1,000 yds. of brick pavement.

WASHINGTON, D. C.—The District Commissioners will receive bids until July 22 for street asphalt block paving.

BUCYRUS, O.—The City Clerk will receive bids until July 19 for paving two streets with brick.

FINDLAY, O.—Bids are asked until Aug. 1 for macadamizing and other work. J. S. Humphrey, Cy. Engr.

MOUNT VERNON, O.—Bids are asked until Aug. 1 for brick paving. Thos. Trick.

TOLEDO, O.—Bids are asked until Aug. 1 for paving three streets with medina stone, brick, cedar blocks, or asphalt. Sylvester Lamb, Cy. Clk.

FORT WAYNE, IND.—Bids are asked until July 26 for 20 contracts for grading, brick walks, etc. F. M. Randall, Cy. Engr.

INDIANAPOLIS, IND.—The Board of Public Works will receive bids until July 20 for paving one street with brick and two with Trinidad asphalt.

HASTINGS, NEB.—Paving bonds for $24,000 have been voted.

OMAHA, NEB.—The Council has voted to pave Twenty-second St. The Board of Public Works will receive bids until July 22 for several grading contracts.

SIOUX FALLS, SO. DAK.—The city has awarded contracts for paving the principal streets with Sioux Falls jasper, to cost about $100,000.

KANSAS CITY, MO.—The Board of Park Commissioners has reported plans for a boulevard in Eleventh St., estimated to cost $550,000. It is thought that a macadam pavement can be constructed at $1 per sq. yd.

GALVESTON, TEX.—The Board of Public Works will receive bids until July 30 for 30,000 cu. yds. sand filling.

ELECTRICAL.

BURLINGTON, VT.—The promoters of the Vermont Electrical Co. have already secured business to the amount of $10,000 per annum, which is a sufficient guarantee to install their plant.

CAMBRIDGE, MASS.—The Committee on Roads and Bridges recommends that permission be granted to Harvard College to lay main wires and a conduit across Cambridge and Kirkland Sts.

AUBURN, R. I.—A committee has been appointed to obtain an estimate of the cost of an electric light plant.

GENEVA, N. Y.—The Geneva Brush Electric Light & Power Co. is reported about to increase its plant at a cost of about $70,000.

NORTH TONAWANDA, N. Y.—The Standard Electric Light & Power Co. has been organized to supply light in this town, Amherst, Grand Isle, Niagara and Wheatfield. Address Geo. P. Smith.

HAUGHVILLE, IND.—A contract has been awarded to the Indianapolis Light & Power Co. for ten years at $90 per light per year, additional lights to 22 at $85.

MARSHFIELD, WIS.—The Council has granted a franchise to Wm. H. Uphan for the construction of an electric light plant. Work will begin at once.

BELLEVILLE, ILL.—The Belleville Electric Light & Coal Co. has been awarded a contract for 100 lights for five years at $100 per light per year.

SHELBYVILLE, ILL.—Bids will be received until July 20 for lighting the streets for five years from Sept. 1. J. M. Kutze, Chn. Com.

NEW COMPANIES.—Ceramic City Light Co., Newark, N. J.; $50,000; R. Arter, New Lisbon, O.; W. H. Murphy, East Liverpool, O. Cleburne Water, Ice & Lighting Co., Cleburne, Tex., $100,000; S. W. Lovelady, L. W. Chase, B. Gray, Hollidaysburg Electric Light & Power Co., Hollidaysburg, Pa.; $25,000; John Loudon, A. J. Anderson, Standard Electric Light & Power Co., North Tonawanda, N. Y.; $100,000; G. P. Smith, G. B. Warren, Gainesville Light & Power Co., Gainesville, Ga., $50,000; G. W. Walker, E. E. Dixon.

CONTRACT PRICES.

SEWERS.—Waukegan, Ill.—We are informed by John A. Cole, Engr., Chicago, that the contract for a sewage system at this place has been awarded to J. P. Fox, Eau Claire, Wis., at the following prices: 60-in., 260 ft., av. cut 9 ft., $6 per ft.; 54-in., 460 ft., 13.7 ft. cut $5.95; 36-in., 490 ft., 10.3 ft. cut, $4.30; 28 × 42 ins., 1,520 ft., 13.1 ft. cut, $4.67; 24 × 36 ins., 1,361 ft., 9.4 to 11.7 ft. cut, $4.10 and $4.22.; 20 × 30 ins., 343 ft., 11 ft. cut, $3.10; 18 × 27 ins., 1,983 ft., 10.1 to 11.4 ft. cut, $1.49 to $1.91; 16 × 24 ins., 815 ft., 9.8 to 11.7 ft. cut, $1.60; 14 × 21 ins., 2,078 ft., 7.5 to 10.8 ft. cut, $1.24 and $1.44; 15-in., 2,711 ft., 7.7 to 10.9 ft. cut, 85 and 95 cts.; 12-in., 5,541 ft., 6.5 to 11.1 ft. cut, 55 to 75 cts.; 10-in., 1,847 ft., 7.6 to 9.6 ft. cut, 55 to 60 cts.; 9-in., 3,204 ft., 4.9 to 9.6 ft. cut, 45 to 60 cts.; 8-in., 4,166 ft., 8.2 to 10.1 ft. cut, 45 to 53 cts.; 6-in., 6,202 ft., 6.7 to 9.1 ft. cut, 40 and 45 cts.; 147 manholes, $28 each; 120 catch basins, $32; 3 special manholes, $45; 11 flush tanks, $75; bulkhead and outlet with 300 ft. 20-in. wrought iron pipe, $900; temporary outlet of 20 ft. 15-in. pipe, 10.5 ft. deep, into culvert catch basin, $45.

STREET WORK.—Dunkirk, N. Y.—We have received from F. A. Dunham, Cy. Engr., the following statement of the lowest bids received for the improvement of Second St.: F. G. Barber, Pittsburg, Pa., excavation, 4,175 cu. yds., 30 cts per cu. yd.; paving with brick on concrete, 16,706 sq. yds., $1.80 per sq. yd.; same with brick on broken stone, $1.64; curbing, 8,850 lin. ft., 43 cts.; curbing reset, 1,000 ft., 10 cts.; circular curb corners, 195 ft., 70 cts.; drain tile, 9,000 lin. ft., 10 cts. Barber Asphalt Paving Co., excav., 35 cts.; paving with asphalt, $2.37; curbing, 43 cts.; reset, 10 cts.; circular, 50 cts.; drain tile, 8 cts. Jacob Rider, excav., 30 cts.; telford macadam pavement, $1.40; curbing, 45 cts.; reset 20 cts.; circular, $1.50; stone crosswalks, 4,850 sq. ft., 50 cts.; stone crosswalks relaid, 100 sq. ft., 25 cts. Chas. E. Willims, excav., 40 cts.; medina stone pavement, $2.84; curbing, 45 cts.; reset, 4 cts.; circular, 45 cts.; stone crosswalks, 40 cts.; relaid, 6 cts.; drain tile, 13 cts. It is probable that the contracts for both Second and Lion Sts. will be awarded to F. G. Barber at above prices.

Norristown, Pa.—We are informed by M. D. Patterson, Engr., that the contract for paving Main and DeKalb Sts., with Pennsylvania granite blocks on 6 ins. concrete, pitch cemented joints, was awarded July 1 to John I. Dyer, at $2.70 per sq. yd., which includes all excavation and lowering street car tracks.

Montreal, Que.—The Sicilian Rock Asphalt Paving Co. has been awarded three contracts at $3.33 per sq. yd. for asphalt, 20 to 28 cts. per ft. for 6 × 12 ins. New York flags, and 26 cts. for scoria blocks along car rails.

Boston, Mass.—Contracts have been awarded as follows: J. Doherty & Co., 1,800 sq. yds. block stone pavement, tar joints, 91 cts. per sq. yd.; Jones & Meehan, 8,000 sq. yds., granite block pavement on 6 ins. concrete, $2.75; 2,500 lin. ft. edgestone, 35 cts.; 1,500 sq. yds. brick sidewalk, 65 cts.; 1,200 sq. yds. flag crosswalks, $2.70. The blocks, brick and stone are furnished by the city.

EXCAVATING.—Detroit, Mich.—The contract for excavating St. Mary's Falls Canal has been awarded by Gen. Poe to Dunbar and Sullivan, Buffalo, N. Y. The material to be excavated consists chiefly of Potsdam sandstone rock in stratified layers of varying thickness. The work is to be completed in two years. The price for the first section, 138,700 cu. yds., is $1.53 per cu. yd., and for the second section, 138,800 cu. yds., $1.47.

Boston, Mass.—The Park Department has awarded to Thos. A. Rowe and Daniel Hall the contract for excavating and grading ponds in Franklin Park. The work comprises 16,000 cu. yds. of loam stripping, 47,000 cu. yds. of earth excavation and 50 cu. yds. of rock excavation. Their bid was 38½ cts. per cu. yd. for loam, the same for earth, and $1.50 for the rock. The other bids varied from 30½ cts. to 72 cts. for loam and 38¾ cts. to 60 1-10 cts. for earth.

CEMENT.—Boston, Mass.—Lieut.-Col. S. M. Mansfield has opened the following bids for 9,000 bbls. of American cement: C. C. McColgan Co., Baltimore, Md., $1.25 per bbl.; G. M. Winslow & Co., Mortou's, $1.25; Rosendale, $1.10; G. W. Nash, $1.02; T. W. Carter, $1.02; Waldo Bros., 99 cts.; E. G. Kent, 99 cts.

Seattle, Wash.—The contract for Portland cement has been awarded at $2.69 per bbl.

WATER-WORKS SUPPLIES.—Orange, N. J.—The contract for iron pipe has been awarded to Pancoast & Rogers, at $26 per ton for 4-in., and $25.50 for 6-in. pipe.

Austin, Tex.—The contract for 5,750 tons of pipe and 115 tons of specials, size 16-in. and under, has been awarded to Walter Tips, at $21.95 per ton for pipe and $45 for specials.

BRICK.—Toronto, Ont.—Contracts have been awarded to A. W. Goodson, at $7 per m., and Taylor Bros., at $7.50 per m.

DREDGING.—New York, N. Y.—The contract for dredging at Staten Island has been awarded to J. P. Anderson, Albany, at $1.39 per cu. yd.

Albany, N. Y.—The contract for dredging 22,000 cu. yds. for the Hudson River, opposite Coeymans, has been awarded to P. W. Myers, at 9¾ cts. per cu. yd.

BREAKWATER.—Portland, Me.—Col. P. C. Hains has opened the following bids for constructing the breakwater at Little Harbor, N. H.: Thos. Ziddle, Boston, Mass., $1.24 per ton; J. T. Hamilton, Portland, $1.45; G. W. Andrews, Biddeford, $1.11. The work will require 24,000 tons of stone.

MISCELLANEOUS.

DREDGING AND DUMPING BOARD.—New York, N. Y.—The Department of Docks asks bids until July 21 for dredging about 335,000 cu. yds.; also for a new dumping board on pier 61.

FOUNDATION WORK.—Chicago, Ill.—The Board of Directors of the Chicago Public Library will receive bids until July 19 for excavation, piling, masonry, concrete work, etc.

PLANS FOR PUBLIC BUILDINGS.—Victoria, B. C.—The Commissioner of Lands and Works asks architects to submit until Sept. 30 competitive plans and estimates for certain government buildings.

HARBOR IMPROVEMENTS.—St. John, N. B.—The Board of Works has been authorized to ask for bids for the harbor improvements at Sand Point, Carleton.

RESERVOIR WORK, ETC.—Albany, N. Y.—Bids are asked until July 20 for clearing ground, raising roads and bridges, and completing the dam for the reservoir on Black River above Forestport Pond. Edward Hannan, Supt. Pub. Wks.

GAS.—Chicago, Ill.—The Cicero Gas Co. has been incorporated by C. D. Hauk, H. C. Reid and N. A. McClary; capital, $5,000,000. The North American Gas Co. has been incorporated by C. M. Hill, J. D. Cameron and J. R. D. Graham; capital $500,000.

STONE DAM.—Little Falls, N. Y.—Surveys are being made for a new stone dam to be built across the Mohawk River at Hensen's Island. The sum of $16,000 has been appropriated for the work.

WHARF.—St. John, N. B.—The Board of Public Works will soon ask for bids for a wharf at Sand Point, Carleton, to cost $125,000.

BOILER HOUSE.—Cleveland, O.—The Board of Control will receive bids until July 13 for a stone and brick boiler house and chimney.

RETAINING WALL.—Boston, Mass.—The Superintendent of Streets will receive bids until July 11 for a retaining wall on L St., South Boston.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Schenectady Locomotive Works, Schenectady, N. Y., exhibited 3 two-cylinder compound engines at the Master Mechanics' Convention at Saratoga; an eight-wheel passenger and a ten-wheel freight engine for the Adirondack & St. Lawrence, and a twelve-wheel freight engine for the Southern Pacific. The Pittsburg Locomotive Works, Pittsburg, Pa., have built 2 fast passenger engines for the Pittsburg & Lake Erie. The Baldwin Locomotive Works, Philadelphia, Pa., have an order for 4 passenger and 2 switch engines for the new Sandusky & Columbus, now under construction. The Cooke Locomotive Works, Paterson, N. J., have orders for 3 eight-wheel engines for the Evansville & Terre Haute, and another for the Lehigh & Hudson. The Long Island has added 20 engines to its equipment. The Dickson Mfg. Co., Scranton, Pa., is building 10 consolidation engines for the New York, Ontario & Western. The Cooke Locomotive Works, Paterson, N. J., are building 20 consolidation and 5 ten-wheel engines for the Louisville & Nashville, and 3 ten-wheel engines with cylinders 21 × 26 ins. for the Everett & Monte Christo.

CARS.—The Ohio Falls Car Co., Jeffersonville, Ind., has built 300 gondolas and 300 box cars, all of 60,000 lbs. capacity, for the Ohio Southern. The Jackson & Woodin Mfg. Co., Berwick, Pa., has an order for 500 freight cars for the Buffalo, Rochester & Pittsburg. The Laconia Car Co., Laconia, N. H., is building 100 cars for the Burton Stock Car Co. The Chicago, Burlington & Quincy is building 10 suburban cars at its

shops at Aurora, Ill. The Long Island has added 25 passenger and 125 freight cars to its equipment. Caswell Stock Car & Transportation Co., Chicago, Ill.; $4,000,000; Mr. H. Naber, Rookery Building; W. A. Caswell. The St. Charles Car Co., St. Charles, Mo., is building 10 passenger cars for the St. Louis, Vandalia & Terre Haute. The Jackson & Sharpe Co., Wilmington, Del., is building 50 passenger cars for the Chicago, Burlington & Quincy. The Chicago Car Appliance Co., Chicago, Ill., has been organized by John E. Tirney, 392 Wabash Ave., and H. B. Reed; capital stock, $100,000. The Norfolk & Western has placed an order with the Pullman Palace Car Co., Chicago, for 25 vestibuled cars, 20 express cars, 10 baggage cars 52 ft. long, 5 mail cars, 1,000 grain cars, 200 ventilated fruit cars and 400 gondola coal cars. The Haskell & Barker Car Co., Michigan City, Ind., has an order for 200 box cars of 60,000 lbs. capacity for the new Sandusky & Columbus short Line.

CAR HEATING APPLIANCES.—The Consolidated Car Heating Co. has just brought out a dust guard for the Sewall steam hose coupler. It is designed to have the coupler hang in this guard when not in use, thus protecting the face of the coupler from injury. A special hose nipple for the Sewall coupler has also been devised, which fixes the position of the hose when forced on the nipple and insures the standard length being maintained when new hose is substituted for old. A new multiple circuit low pressure hot water system, which works with only 4 lbs. steam pressure, is another of the company's new departures.

CAR LIGHTING.—The Bombay, Baroda & Central India Ry. has begun the use of the Pintsch compressed gas system and is the first railway company in India to adopt gas lighting.

STEEL TIES.—The Sweet Metal Cross Tie Co. has been organized at Los Angeles, Cal., by H. F. Sweet, H. C. Wintenend and C. A. Marriner, with a capital stock of $1,000,000.

BUILDINGS.—Contracts for the following buildings have been awarded to Benjamin Hyde, C. E., Rookery, Chicago; Boyce building, Dearborn St., 40 ft., 8 ins. ×80 ft. 4 ins., 11 stories; Hartford Deposit Co.'s building, 92½ ft., × 150 ft., 15 stories; Kuton building, 60 ft. × 100 ft., 11 stories; U. S. Court House and Post Office building, Detroit, Mich. Mr. Hyde was also contractor for the Title & Trust Building, and the Am. Express Co.'s new barn, 300 ft. × 110 ft., 4 stories, recently completed, and has the contract for the Carolina Hotel, 100 × 100 ft., all steel, 11 stories.

THE WISCONSIN BRIDGE & IRON WORKS, Milwaukee, Wis., has been awarded the contract for furnishing the material for a 200-ft. steel tower to be erected on the South Side, Chicago, near the World's Fair Grounds.

THE CHICAGO SURVEYING & ENGINEERING CO. has been incorporated to carry on a general surveying and engineering business. Mr. J. Q. Baird is the General Manager; F. P. Henry, Secy.; Robt. S. Heo, Attorney. Mr. Baird has been engaged in this line of business for the past 12 years, and prior to May 1 was Chief Engineer of the Lake St. Elevated Ry. The offices of the company are in the Opera House Building, Chicago.

THE ASHTON VALVE CO., Boston, Mass., has bought the entire plant, material and business of the Boston Steam Gage Co., and has consolidated the business with its own, retaining the former manager, Mr. H. L. Willard.

THE THOMSON METER CO. gave the second annual outing to its employees at Grand City, S. I., on July 2. The company reports great success with its meter.

MR. LEE L. DAGRON, Rookery Building, Chicago, has a contract for inspecting the material for the Hyde Park elevated line of the Illinois Central R. R.

THE AQUA SUPPLY CO., Baltimore, Md., has been incorporated by C. E. Emig, of Baltimore; Levi Naish, of Washington, D. C., and E. P. Stair, of York, Pa.; $50,000. The company proposes to build water-works on a new system, and to contract for deep well drilling. Six contracts have been taken.

THE VERMONT CONSTRUCTION CO., St. Albans, Vt., has let contracts for a new shop 125 × 50 ft. for bridge work, and a new blacksmith shop 50 × 40 ft., in consequence of the growth of its bridge building business.

THE BERLIN IRON BRIDGE CO., East Berlin, Conn., has designed and is building a new iron mill for the Waterbury Brass Co., Waterbury Conn. The rolling mill will be 100 × 60 ft., with a wing 40 × 230 ft., to be used for drawing wire.

THE AMERICAN ENGINEERING AND INSPECTION ASSOCIATION, Albany, N. Y., announces that it is prepared to undertake the designing and supervision of structural work, and the inspection of structural and railway material of every kind. The department of structures is in charge of Mr. Chas. F. Stowell, Bridge Engineer of the Adirondack & St. Lawrence Ry., and for the past eight years Bridge Engineer of the New York State Board of Railroad Comrs., which position he now leaves. The department of construction and erection is in charge of Mr. M. C. Clay, who has had long experience as a practical iron worker, superintendent of shop and field work, superintendent of bridges on the West Shore R. R., etc. The department of manufacture is in charge of Mr. A. C. Cunningham, formerly with the Massillon Bridge Co., and G. W. G. Ferris & Co., civil engineers and inspectors of iron and steel, and who resigned the position of chief inspector at the Upper and Lower Union Mills of Carnagie, Phipps & Co., to take charge of this department. A new feature is offered in the systematic inspection of finished structures, either for special purposes, or periodically, at stated intervals. It is believed that this will commend itself especially to railway companies which do not maintain a permanent bridge force, but which have occasional need of such service. Another feature will be the strengthening of old bridges to meet the requirements of modern traffic, and the association is also prepared to make inspection and tests, both physical and chemical, of rails, axles, couplers, pins and links, fish plates, bolts, spikes, and locomotive and car materials.

THE PITTSBURG TESTING LABORATORY, through its Western representative, W. A. Aiken, M. Am. Soc. C. E., is to test 750 tons of reamed steel for a new viaduct at High Bridge, Ia., on the Des Moines, Northern & Western Ry. The material will be furnished by the Chicago Bridge & Iron Works. Mr. Aiken has recently completed the inspection of 3,000 tons of steel rails for the "Nickle Plate" line, furnished by the Illinois Steel Co., and 1,000 tons for the Portsmouth Fire Brick Co., Newport News, Va., and the standpipe for the new water-works at Fort Worth, Tex., manufactured for the Porter Boiler Mfg. Co., Chicago.

NEW COMPANIES.—Bell Waterphone Co., Chicago, Ill.; $100,000; H. M. Lewis, C. F. Dunderdale and O. C. St. Clair. Standard Paving Co., Chicago, Ill.; $50,000; T. G. Griffin, P. E. Johnson and H. L. Vallette. Hyde Park Portland Cement Paving Co., Chicago, Ill.; $50,000; James Nellis, J. H. Trendenthal and C. G. Smith. Yankee Portland Cement Co., Chicago, Ill.; $3,000,000; Wm. P. Davey, E. A. Bruce and Wm. E. Shaw. Fiberite Co., Mechanicsville, N. Y.; $50,000; to manufacture electric and street railway appliances; Pres., H. J. Melbry, Boston, Mass. Northwestern Drain Tile Co., Superior, Wis.; $60,000; G. J. Miller, J. H. Harrington and E. Westrom. Rockland Const. Co., Rockland, Me.; for quarrying granite and building backwaters, etc.; $10,000.; Pres., Wm. S. White, Spiral Tower & Observatory Co., Chicago, Ill.; $200,000; D. C. Brunson, Wm. C. Stevens and L. W. Cars. Chicago Car Appliance Co., Chicago, Ill.; $100,000; J. E. Turney, H. W. Reed and O. S. Reed. Cycloid Railway Construction & Equipment Co., Brooklyn, N. Y.; $15,000; to operate the patents of Louis C. d'Homergue; J. J. Bryers, J. B. d'Homergue and J. A. Anderson. Single Track Overhead Railway Mfg. Co., Philadelphia, Pa., $50,000; A. R. Miller, of Philadelphia; H. G. Vennell, Pavonia, N. J. Blackmer & Post Co., St. Louis, Mo., $300,000; L. R. Blackmer, L. W. Post and Ernest Argo, Detroit. The Bermundez Paving Co.; $25,000; T. H. Thomas, New York; S. T. Douglas, Detroit.

CURRENT PRICES.

RAILS.—New York: $30 at Eastern mills, $30.75 at tidewater: old rails, $17 for iron and $17 for steel. Pittsburg: $30; old rails, $20 for iron and $15 to $16 for steel. Chicago: $31 to $31.50; old rails, $18 to $18.25 for iron and $12.50 to $14 for steel.

TRACK MATERIALS.—New York: steel angle bars 1.55 to 1.6 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.5 to 2.6 cts., with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron and 1.8 to 1.9 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.8 cts. for iron and steel; spikes 2.1 to 2.15 cts.; track bolts, 2.55 cts. with square and 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57¼ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing 55 per cent. The "Iron Age" says that little attention is being paid the official discounts, and they still continue to be shaded very materially.

FOUNDRY PIG IRON.—New York: $14 to $15.50. Pittsburg: $14.35 to $14.60; Chicago: $13.50 to $15.

LEAD.—New York: 4.25 cts. Chicago: 4 to 4.07 cts. St. Louis: 4.05 to 4.1 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.15 to 2.5 cts. for large lots, and 2.25 to 2.65 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.85 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.8 to 2.25 cts.; steel plates, 1.8 to 1.9 cts., for tank, 2 to 2.25 cts., for shell, 2.3 to 2.65 cts., for flange, 3. to 3.25 cts. for firebox. Pittsburg: beams, 1.9 to 1.95 cts. for large lots, and 2 to 2.05 cts. for small lots; channels, 1.9 to 1.95 for large lots, and 2 to 2.05 cts. for small lots; angles, 1.8 to 1.85 cts.; tees, 2.35 cts.; universal mill plates, 1.8 to 1.9 cts. for iron and steel; sheared steel bridge plates, 1.95 to 2 cts.; refined bars, 1.65 to 1.7 for iron and steel; steel plates, 1.75 to 1.85 cts. for tank, 2 to 2.1 cts. for shell, 2 to 2.1 cts. for flange, 3.5 to 3.75 cts. for firebox. Chicago: beams, 2.1 to 2.05 cts. for large lots, and 2.15 to 2.25 cts. for small lots; channels, 2.15 to 2.25 cts.; angles, 1.9 to 2.1 cts.; tees, 2.35 to 2.4 cts.; universal plates, 1.9 cts.; sheared steel plates, 2 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.0 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.

NOTICE TO SEWER CONTRACTORS.

City Engineer's Office, Room 6, City Hall.
Danbury, Conn., July 9, 1892.

Sealed proposals will be received until 8 p. m., July 20th, by the Committee on Sewers, for constructing sewer and appurtenances on Highland Ave. and Morris St., comprising approximately:

526 lin. ft. 18-in. vitrified pipe sewer.
235 lin. ft. 15-in. vitrified pipe sewer.
735 lin. ft. 12-in. vitrified pipe sewer.
305 lin. ft. 10-in. vitrified pipe sewer.
100 lin. ft. 10-in. pipe culvert.
40 lin. ft. 12-in. pipe culvert.
12 manholes.
8 catch basins.

Also proposals for constructing sewer and appurtenances on Comstock St., including a portion each of Pahquioque Ave. and East Liberty St., comprising approximately:

860 lin. ft. 12-in. vitrified pipe sewer.
440 lin. ft. 10-in. vitrified pipe sewer.
60 lin. ft. 10-in. culvert pipe.
10 manholes.
5 catch basins.

Plans and specifications can be seen and information obtained at this office. Each bid must be accompanied by a certified check in the sum of $300 payable to the order of the city of Danbury. Said check to be forfeited in case the contract is not entered into, if awarded.

No proposals will be received after the time specified and all proposals not made out on blanks furnished, or in any manner informal, will be rejected.

The right is reserved to reject any or all bids.

E. M. FARNUM,
C. QUIEN,
CHARLES BENNETT,
Sewer Committee.
J. K. WILKES, City Engineer. 29-1t

PROPOSALS FOR SEWERS.

Sealed proposals will be received at the office of the Commissioners of Public Works, addressed to Charles Francis, Commissioner of Public Works, Davenport, Ia., and endorsed "Proposals for Main Sewer in Fourth District," to be opened on the 13th of August, 1892, at noon, for the material and work necessary for the construction of the following sewers:

I. 3,176 lin. ft. of vitrified sewer pipe, 20 ins. internal diameter, with the necessary branches, Y's and manholes, Locust St.

II. 3,931 lin. ft. of vitrified sewer pipe, 20 ins. internal diameter, with the necessary branches, Y's and manholes.

III. 1,694 lin. ft. of vitrified sewer pipe, 22 ins. internal diameter, with the necessary branches, Y's and manholes.

IV. 5,592 lin. ft. of vitrified sewer pipe, 24 ins. internal diameter, with the necessary branches, Y's and manholes.

V. 1,870 lin ft. of 2×3 ft. egg shaped sewer, built of brick in two rings, with the necessary branches, connections and manholes.

The above lengths are approximate only, and the Commissioners reserve the right of increasing or diminishing them, as in their opinion may be necessary.

The person or persons to whom the contract is awarded, will be required to attend at the office of the Commissioners of Public Works, with sureties offered by him or them, and execute the contract within five (5) days of the service of a notice to that effect, and in case of failure or neglect to do so, he or they will be considered as having abandoned it.

Each proposal must be accompanied by a certified check for five hundred dollars ($500); that is, if a bidder desires to propose for whole five sewers, he must deposit a check for twenty-five hundred dollars ($2,500) payable to the order of the Mayor of Davenport, in case the party to whom the contract is awarded shall fail to execute the contract so awarded within five (5) days of the service of a notice to that effect.

Bidders will state in writing, and also in figures, the price per lineal foot of above sewers, which price shall include all branches, Y's and connections. Bidders will examine the plans and specifications on file at the City Engineer's office, City Hall, and also the grounds, and judge for themselves of all the circumstances affecting the cost of the work, or time required for completion, in order that no misunderstanding may exist in regard to the character of the ground and other circumstances in relation to the complete construction of the work.

The Commissioners reserve the right to reject any or all bids, or parts of bids which may not be deemed advantageous to the city.

CHARLES FRANCIS,
Commissioner of Public Works.
Davenport, Ia., July 8, 1892. 29-1t, 31-1t

PROPOSALS.

Sealed proposals, indorsed "Tenders for Trenching and Pipe Laying," will be received at the office of the Syracuse Water Board, City Hall, Syracuse, N. Y., until 2 o'clock p. m. of Monday, July 25, 1892, for trenching and laying cast iron water pipe and special castings, setting stop-gates, hydrants and other work connected therewith, in the city of Syracuse, as follows:

A 16-in. main in South West St., from the Erie Canal to Gifford St., 2,550 lin. ft., and an 8-in. main from Gifford St. to Onondaga St., 1,913 lin. ft. Also a 10-in. main in South Ave., from Onondaga St. to Cortland Ave., 3,900 lin. ft. The work must be completed not later than the first day of November next. The contractor to whom the work may be awarded will be required to execute the contract with the required surety in the sum of $1,500 within five days after notice of the award. Blank forms of contract, specifications, bond and proposals, can be obtained at the Engineer's office of the Syracuse Water Board, Room 8, Granger Block, in said city, on application. JAMES B. BROOKS,
Secretary Syracuse Water Board.
Syracuse, N. Y., July 8, 1892. 29-2t.

UNITED STATES ENGINEER OFFICE, Boston, Mass., June 25, 1892.—Sealed proposals, in triplicate, will be received at this office until noon of July 25, 1892, for the delivery of eighteen thousand barrels of American hydraulic cement, at Fort Warren, Boston Harbor, Mass. Attention is invited to the Acts of Congress, approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. For full information apply to S. M. MANSFIELD, Lieut. Col. of Engineers. 28-3t

U. S. ENGINEER OFFICE, Custom House, Cincinnati, Ohio, July 11, 1892.—Sealed proposals for furnishing cement, lumber, tie rods and washers, required for lock and movable dam No. 6, Ohio River, near Beaver, Pa., will be received at this office until 2:30 p. m., August 1, 1892, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. AMOS STICKNEY, Major of Engineers, U. S. A. 29-2t